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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES' EQUIPMENT AND SUPPLIES ASSOCIATION.

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The B.C.I.R.A. Scottish Laboratories are:—
Foundry Technical Institute, Meek's Road, Falkirk (*Telephone* 332).

Forthcoming Events.

OCTOBER 25.

Sheffield Metallurgical Association:—Ordinary meeting. "Discussion on Pyrometry" in connection with Section V, Pyrometric Sub-Committee. "Fourth Report on Heterogeneity of Steel Ingots," introduced by Messrs. A. Stanfield, Todd and Elcock.

Institute of British Foundrymen.

OCTOBER 22.

East Midlands Branch:—Ordinary meeting at Leicester. "Some Factors influencing the Production of Sound Non-Ferrous Castings," Paper by F. W. Rowe, B.Sc.

Scottish Branch:—Ordinary meeting at Edinburgh. "The Manufacture of Cast Iron in the Brackelsberg Furnace," Paper by P. M. Macnair, Ph.D.

OCTOBER 27.

Newcastle-upon-Tyne and District Branch:—Ordinary meeting. "The Manufacture of the Mammoth Cunard Castings," Paper by F. Swift.

Sheffield and District Branch:—Visit to Ley's Malleable Castings Company, Limited.

OCTOBER 28.

Middlesbrough Branch:—Ordinary meeting. "Some Aspects of Jobbing Moulding, with some Gating Suggestions," Paper by S. Southcott.

The New Patent Act.

The Patents and Designs Act which comes into force on November 1 is of paramount importance to our readers, as it effects considerable changes in existing conditions. Primarily the period of provisional protection is extended by three months, so that in future the complete specification may be lodged any time within twelve months after the date of application. This has been done to make it coincide with international arrangements, and if foreign cover is desired, then such demands must be despatched before the complete specification is on file in this country. Moreover, unless the complete specification following the provisional application is left well before the expiration of twelve months, the search on novelty made by the Patent Office, the result of which usually influences the applicant's decision with regard to foreign patents will not be available.

An applicant now has the option of asking the Comptroller to treat a complete specification filed with the application as though it were a provisional one or to ask that an application may be post dated, any time before acceptance, for a period not exceeding six months—a sometimes risky procedure.

An important change concerns the search for novelty. Prior to the new Act, British search was confined to the investigation of previous British patent specifications filed on applications for patents during the last fifty years. Now the search is extended to include foreign specifications and other documents, such as the technical Press, which brings it into line with certain foreign countries. It should be remembered that even then the granting of a patent is no guarantee of its validity. This departure naturally involves enhanced work on the part of the Patent Office officials, and as a result the time for obtaining acceptance has been extended to 18 months from the application date, whilst the fees payable on filing a complete specification have also been increased. So, too, the sealing period has been extended to 21 months, giving the maximum time within which the patent must be sealed, including extensions which are still obtainable as 28 months.

Another phase which has been modified is the grounds upon which an application may be made to the courts for revocation, and refers specifically to the method dealing with an assortment of claims, some of which may be valid and some invalid. Another alteration is a really wise one, as it empowers the Comptroller to refuse to grant patents for such silly scientific impossibilities as "perpetual motion machines" and the like. Another welcome change refers to the law for the tightening up of action in the case of groundless threats of legal proceedings, whilst others relate to the granting of a patent to an assignee; the hearing of appeals from the Comptroller's Court by an Appeal Tribunal and amendments in the law dealing with British applications filed in other countries. Finally, it should be noted that the new Act applies to applications filed before as well as after the passing of the Act. We wish to acknowledge our indebtedness to Mr. Bertram T. King, Registered Patent Agent, of Wardrobe Chambers, London, E.C.4, for supplying information upon which our remarks are based.

Metallurgical Coke.

Some useful particulars respecting the coke industry were given in a recent Paper by Mr. R. A. Mott, M.Sc., F.I.C. Founders are particularly interested in this question because it is doubtful whether the coke-oven industry could be kept alive merely on the foundry demand, so that the influences which affect the demand for coke for other purposes indirectly concern the foundry trade. The output of oven coke in recent years is about the same as it was 20 years ago, and, except during the slump periods, the output of coke has fluctuated between 11,000,000 and 13,000,000 tons per annum—following the output of pig-iron, the manufacture of which consumes about 65 per cent. of the total output, compared with 89 per cent. 20 years ago. The proportion of the total used in foundries is given as about 5 per cent., based on an estimate furnished by Mr. J. E. Fletcher. The falling-off in the blast-furnace demand has been compensated by a material increase in the amount of coke used for domestic purposes and in the amount exported.

Whilst there has been a material increase in the amount of gas manufactured in the period of 20 years the same increase in gas-coke available for inland sale has not occurred, because the make of gas per ton of coal has increased by the use of higher temperatures and the use of vertical instead of horizontal retorts. Recent political changes and statistical considerations suggest that by 1940 there will be a steel production of 16,000,000 tons and a consequent pig-iron output of about 12¾ million tons. This would demand about 16,000,000 tons of coke, which is about double the average for the years 1928-30.

Founders are well aware that the commercial values of metallurgical cokes are in the order of South Wales, Durham, Yorkshire, Derbyshire. Taking Durham coke as equal to 100, Mr. Mott gives the following price ratios for coke from these four areas:—South Wales, 105; Dur-

(*Concluded on next page.*)

High-Duty Cast Iron.

MR. R. S. MACPHERRAN'S REPLY TO BRITISH CRITICISMS.

The author wishes to express his appreciation of the friendly tone shown in the discussion of the Paper on "High-Test Iron" which he presented on behalf of the American Foundrymen's Association to the Newcastle Conference of the Institute of British Foundrymen.

Mr. Hudson is correct in assuming that the cost of the mixture in the ladle was not a primary reason for the development of this material. What was desired was a very strong, dense material, but not too difficult to machine. With regard to the use of alloys to reduce machine time, it should be pointed out that this factor becomes more important as the rate per hour paid to workman increases. For example, it might be profitable for one shop paying the men three shillings an hour to add alloys to reduce the machine time of a certain casting by one hour. The same alloy addition might not be profitable in a shop where the men were paid only one shilling per hour. Comparative costs will vary not only between different countries but between different cities in the same country and there would be still more variation from year to year. The costs given for the mixture used in the electric furnace and referred to by Mr. Kain were based on materials purchased in 1929 and 1930. The same materials purchased in 1932 would be materially lower. The pouring temperatures were, unfortunately, not a matter of record, but tests made in 1931 show a temperature of 1,500 deg. C. as coming from cupola, 1,330 deg. C. as poured into moulds. As to the amount of scrap used in mixtures, it should be pointed out that the amount produced in excess of that used in the high-test mixture was added with advantage to our other mixtures. The small ladle addition of ferro-manganese-silicon had no visible effect on the temperature of the metal. The author's concern had no experience with the addition of calcium-silicide.

In reply to the question of Mr. Neath as to the effect of section, it can be stated that there is a greater loss of strength than of hardness as one went from the outside to the centre of the large section. In the case referred to, that of a 1¼-in. dia. bar, it was a separately-cast test-specimen, and the 6-in. section was cut from the centre of the 25-ton casting. As Mr. Neath points out, there is often a variation of strength from ladle to ladle and from day to day. These heats were not made on experimental work, and varied from day to day in amount melted and in size of ladles. In general, it was found that a high pouring temperature was favourable to high loads. This meant indirectly that a small ladle, through filling more quickly, was more apt to show a high load than a large ladle.

In reply to Mr. Pearce's question on the composition of materials used, he would say that the ferro-manganese contains 80 per cent. manganese and about 6 per cent. carbon, and that the ferro-manganese-silicon contains manganese 25 per cent. and silicon 50 per cent. The amounts used, however, were so small as not to affect materially the total carbon of the iron in the ladle.

Referring to test-bars, it should be pointed out that all fillets were easy and threads were made to fit a little loosely in the chuck. Every effort was made to have the load applied axially with no bending moment. Many American companies use a ball-and-socket holder. After machining, the surface of the test specimen is ground or polished. Bars so prepared and tested will probably average a higher load than when less care is taken. We regard these details as being legitimate when making tests of cast iron, as the tensile test has sometimes suffered from lack of such precautions.

District Presidents.—No. 9.

BIRMINGHAM SECTION OF THE INSTITUTE OF METALS.

Mr. W. E. Ballard was born in 1896 and was educated at the Birmingham Central Secondary School. He studied metallurgy under Dr. Johnson, of the Birmingham Municipal Technical College, and was employed as a metallurgist by Sir Gerrard A. Muntz. During the war he served in the Royal Engineers in France and was wounded in 1918. In 1919 he was appointed Research Investigator with Mr. T. G. Bamford, M.Sc., to the recently-formed Brass and Copper Research Laboratory, which was under the direction of Prof. T. Turner on behalf of the Non-Ferrous Research Association. Jointly with

Mr. W. E. Ballard

(Chairman of the Birmingham Section of the Institute of Metals).

Mr. Bamford, he has presented a Paper on "The Influences of Gases on Castings of High-Grade Brass." In 1921 he resigned from the Research Association to take up a position with the Muntz Metal Company, and whilst there he gave a Paper to the Faraday Society jointly with Mr. R. Vaudrey on "Internal Stresses in Brass Tubes." In 1922 he was appointed to the position of metallurgist with Metallisation, Limited, and became a director of that company shortly afterwards, which position he still holds. He has published several Papers on metal spraying.

(Concluded from previous page.)

ham, 100; Yorkshire, 89; Derbyshire, 83. The author stresses the fact that the price of coke, like other commodities, is influenced by supply and demand, and shows that when the price has risen the quality has deteriorated, and when the price has fallen the quality has improved. Founders will probably be able to confirm this from general experience, and suggestions are offered for modifying the price in accordance with fluctuations in moisture, ash and sulphur content.

The author suggests that foundry-coke users are conservative and will still pay more for beehive coke than for oven coke from the same coal. He mentions that in Durham beehive coke is valued at 5s. to 10s. per ton more than oven coke, and in South Wales foundry coke is valued at 7s. to 10s. per ton more than furnace coke.

Random Shots.

It will be seen from a perusal of Blue Books that it would appear to be the opinion of Government officials that it is desirable that it should be a feature of their reports that the phrase "It will be noticed" or "It would appear" should appear at least once in every paragraph. Yet it has been observed that it is a fact that many of these publications are nevertheless sadly deficient in "It." It is indeed peculiar, is it not?

* * *

"Marksman" had intended visiting the Motor Show at Olympia on the opening day. He was prevented from doing this however. His car broke down.

* * *

And talking of motor-cars, "Marksman" has happened upon some interesting statistics relating to the sales of motor-cars in New Zealand for the year 1931. Of the total of 6,433 passenger vehicles registered for the complete year, the Ford make headed the list with a total of 1,283, or 19.94 per cent. of the whole. Then came the Austin, with 12.17 per cent., the Chevrolet (11.37 per cent.) and then, occupying fourth place, another British make, Morris, with 9.91 per cent. These four types are easily the most popular motor-cars in New Zealand. The percentage fell heavily to 4.29 per cent. for the fifth maker on the list. Positions five, six, seven and eight were all held by British-made cars—Singer, Essex, Rover and Triumph respectively. An even better showing is made in the figures for February of this year, when United Kingdom cars held eight of the first ten places, displacing, for the first time, both American types from the head of the list. The lead was taken by Morris, with Austin a good second. This good news demands a toast: "To the success of British car manufacturers in the New Zealand market." Waiter, hoi!

* * *

A Scotsman, it is reported, has set up a new cheap-travel record. An Edinburgh man, he bought a 10s. seven-day ticket on the L.M.S. Railway, travelled 1,709 miles in the Border district, did over 14 miles to the penny. "Marksman" does not agree that this is a record. He remembers, some time ago, that the holder of a shilling all-day ticket endured over a couple of hundred miles on the Metropolitan tramway system. One day "Marksman" will endeavour to create an entirely new record by travelling round and round the Inner Circle railway with a penny ticket.

MARKSMAN.

Duke of York at M. & C. Works.

H.R.H. the Duke of York last week inspected the Bridgeton Works of Messrs. Mavor & Coulson, Limited, the makers of conveyors, coal-cutters and loaders. After being welcomed by the directors, the Duke saw the new commercial and drawing offices. Entering the works, he examined skeletons of the Samson and the low-seam Samson chain coal-cutters. From the coal-cutter assembly gallery he crossed to the tool-room gallery and thence to the light-machine shop and the winding shop. The Duke examined an M. & C. arcwaller, and then, descending to the main machine shop, he was greatly interested in the M. & C. Joy loader. Crossing to the testbed, the Duke started a compressed-air Samson coal-cutter for its test, and watched its operation for a few minutes. Later His Royal Highness visited the foundry and the welfare department.

THE POLISH IRON SYNDICATE has been prolonged for three years.

A Foundry Machinery Showroom.

DEMONSTRATIONS UNDER WORKING CONDITIONS.

We stated, in our issue of August 4, 1932, that we would review the machines installed in the showroom of the British Moulding Machine Company, Limited, 237, Weston Street, London Bridge, London, S.E.1. The objects of this showroom are to demonstrate the machines they handle under working conditions and to mount patterns on machines to ascertain the potential output from the types available. In addition to moulding machines there are three other specialities, a riddle, a flask discharger and a core-blowing machine.

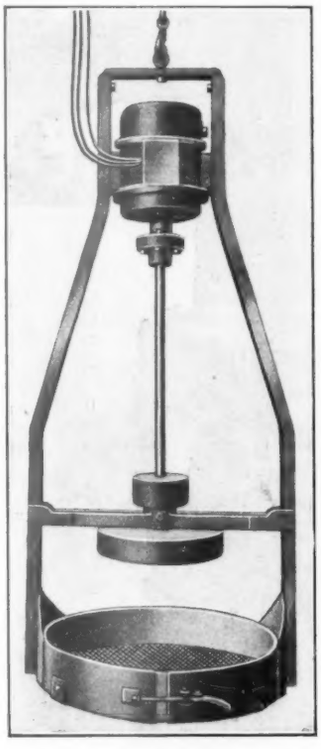


Fig. 1.—A New Type of Gyratory Riddle.

Gyrating Riddle.

The gyratory riddle shown in Fig. 1 consists of a steel framework which houses a ¼-h.p. motor in the top, which is driven from a power-plug. The spindle of the motor is connected by a coupling to the shaft which operates an eccentric flywheel, whilst the bottom end of the shaft is in ball bearings which are housed in a cross member, which can easily be removed from the holder. This riddle is capable of passing 1 ton of sand through a ¼-in. mesh in 5 to 7 minutes.

Hand-Squeeze Moulding Machines.

Installed near this riddle are two hand-squeeze moulding machines. The S.F.I.A. machine has been designed specifically for snap flask work. The machine is rugged and of simple construction, and it will be noted from the illustration (Fig. 2) that the complete-presser head and the pattern table each have a vertical movement along the machined-steel column at the back, the object of this adjustment being to adjust the machine to the most comfortable working position for operators of different stature.

A side shelf is fitted which accommodates the riddle, parting powder, etc., in order to reduce to the minimum the number of motions necessary to make a mould. The ramming of the mould is done by a hand lever which is keyed to an eccentric shaft which is of special steel. This shaft is drilled throughout its length, and a grease lubricator is fitted at the lever end so that ample provision is made for lubricating the connecting rod. The presser plate is adjusted by a hand wheel and the movement is instantaneous.

To enable moulders who are working on benches and troughs to increase their output a presser head having a bracket that can be fitted to the wall or stanchion is available.

The second machine shown, the T.O.2.A, is a turnover machine of simple design, the squeeze mechanism being similar to the S.F.I.A. It is shown in Fig. 3. The pattern table is mounted on two trunnions which stand on a bedplate; the table is free to rotate in these trunnions; at one end of the table is fitted a cam which permits adjusting the pattern table parallel with the draw table.

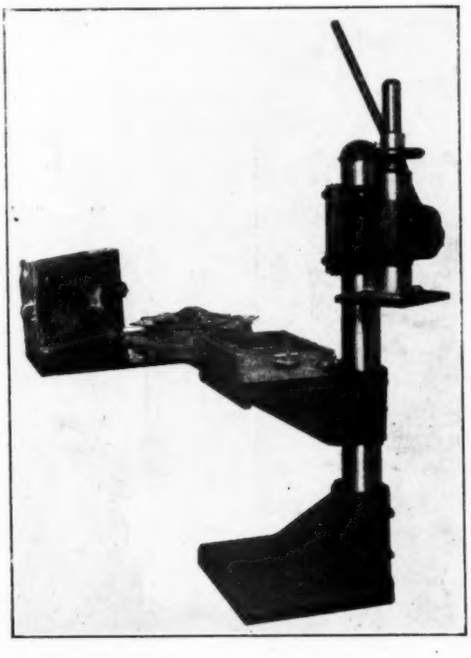


Fig. 2.—A New Design of Simple Hand-Squeeze Machine.

Two clamps are fitted on each trunnion, the right-hand one being to act as a brake when turning over the mould. When the box is full of sand the weight is above the point of balance and it is liable to rotate rapidly and hit the cam stop, or the operator has to hold the box back, but a simple movement of the right-hand clamp makes it possible to rotate the box at will. The left-hand clamp is for locking the pattern table when the draw table is brought into contact with the moulding box; this clamping prevents any possibility of the pattern table moving during the drawing of the mould.

The draw table is operated by the lever on the left-hand side, and the guides work in very long bearings. On the underneath side of each guide there is fitted a cylinder which is filled with oil, which ensures a steady draw without chatter, also giving ample lubrication to the guides.

On a bench in this shop there is a range of patterns showing alternative methods of mounting, some of which exhibit considerable ingenuity.

In the next shop there are the latest Zimmermann machines shown in two types—the U.G.O. and P.W.1. In recent times they have attracted considerable attention on account of their speed and intelligence of design.

The personal element which leads to variation and inaccuracy is virtually eliminated, the operator merely working a number of levers, leaving the machine to make the moulds. Very great attention has been paid to detail, such as the position of the levers, and an effort has been made to eliminate all mechanical troubles caused by sand, dust and rust by adequately protecting the parts liable to be affected and a proper system of lubrication.

The essential part of the U.G.O. machine shown in Fig. 4 is the lifting mechanism: this embodies a pneumatic oil-lifting device which is entirely enclosed in an iron casing. Centrally placed in the bottom of the casing is the lifting cylinder, which is filled with oil. The lifting piston which operates in this cylinder carries a rigid cross member to the end of which are fitted two lifting rods. These lifting rods are carried in bearings fitted to bosses which are attached to the main cylinder of the machine.

The bearings are of such length and capacity as will permit of the storage of an ample quantity of grease, thereby ensuring efficient and continuous lubrication of the complete pattern-lifting mechanism. The lifting is effected by means of compressed air working on oil, which forces it through ports under the lifting piston. In this manner there is no chance of spasmodic movement due to the expansion of the compressed air. The initial movement of the draw is hardly perceptible, but the speed increases automatically, because during the operation an increased number of ports are opened, whilst the lifting piston returns to its original position with equal rapidity.

Embodied in this machine is a new device, the shockless working anvil jolter for simultaneous jolting and squeezing; the jolter continues to work during the squeezing operation. It will therefore be appreciated that the machine can be jolted and squeezed simultaneously or independently in accordance with the requirements of the type of pattern and the nature of the sand. Even fragile plaster patterns can be employed for a long period without damage.

The P.W.1 shown in Fig. 5 is a shockless jolt-squeeze turnover machine, the jolting and squeezing of which is similar to the U.G.O. The outstanding feature of this machine is the rapidity in which complicated moulds can be made. There is usually a great discrepancy in the time taken to make a mould on a straight draw machine and a turnover, but not so with the P.W.1 machine.

When the mould is squeezed against the presser plate it is held in this position during the turning over; this eliminates the use of clamps and reduces the time factor considerably. After turning over, the presser plate forms the lowering table, making it unnecessary to remove sand before drawing the mould. The mould is drawn from the pattern by hand; when returned to its normal position the presser plate automatically returns by its own weight.

The design of the machine ensures an accurate pattern draw, as the pattern table is always in true alignment with the draw table; these patterns require but the minimum amount of taper. The operator has complete control of the lifting mechanism, and jarring during the draw is impossible as an air-cushion is formed in a similar manner to a self-acting door-closer. An adequate generalisation of this machine is a minimum-motion tool with each motion effected rapidly.

Flask Discharger.

The knocking out of large boxes in the foundry is a laborious job, and often involves

boxes being broken, whilst the men have to work amongst and breathe dust-laden air. We were thus interested in the Zimmermann box discharger, which is an all-steel construction worked by compressed air at 80-85 lbs. per sq. in. pressure; it has no springs and will work in any position. To operate, the discharger is hung on the side of the box, which is elevated by the crane, and a lever turned to the "on" position, and instantaneously intense vibration starts, which discharges the sand from the box. We have seen this type of apparatus shown in Fig. 6, being used in malleable foundries for settling down the packing in annealing pots. The final piece of apparatus installed in this show-room is the "Kernhexe" core blower. It is unique in construction and is, we are told, patented throughout the world. The air consumption appeared to be negligible, as it corresponded to the volume of sand required for each core box, and the air in the container does not escape uselessly and noisily after each core is blown, as is sometimes the case.

The machine has a vertical adjustment for varying depths of boxes; the table clamps can also be adjusted for varying widths of boxes. It is fitted with a pneumatic vice operated by a foot pedal, which squeezes the box together and simultaneously vertically presses the core box against the nozzle opening by compressed air. Immediately the core box comes into contact with the nozzle opening, the core box is filled by operating the container lever, which starts an internal stirring mechanism in operation, which prevents any obstruction to the free flow of sand. Generally, the cores are removed from the core box by hand, but when very delicate cores are to be made, it is advisable to use drying shells. When making larger cores, a sand hopper is fitted above the machine.

Whilst abroad and in Manchester and Birmingham one finds demonstrations foundries, it is particularly pleasing that London, too, should have one.

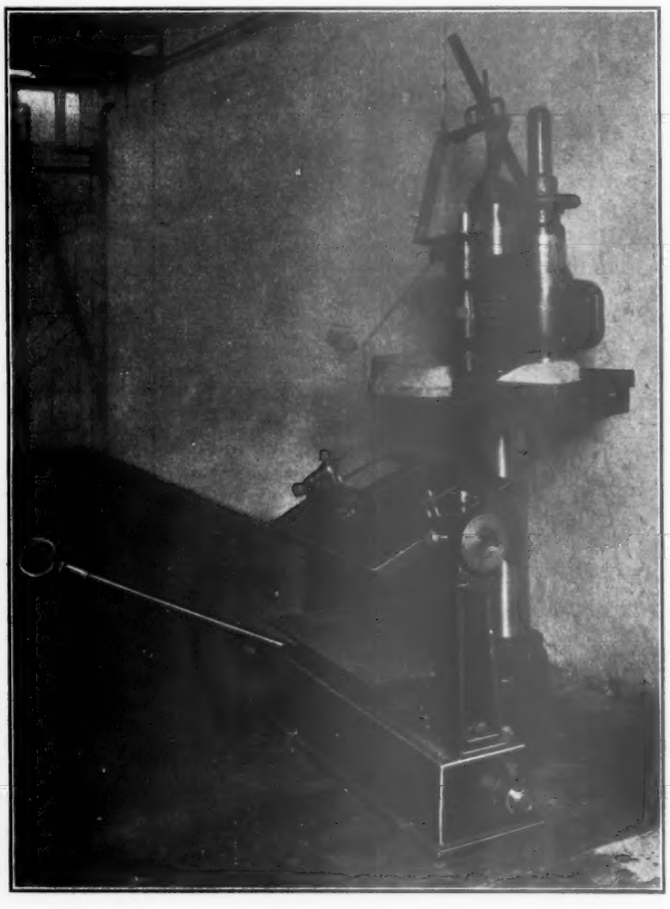


Fig. 3.—A Modification of the Machine shown in Fig. 2 to incorporate a Turn-over Mechanism.

Fig. 4.—The U.G.O. Jolt-Squeeze Machine.

Notes from I.B.F. Branches.

West Yorkshire Ironfounders.—The new winter programme of the West Yorkshire Branch of the Institute of British Foundrymen, which opened with the delivery of the Presidential Address at Bradford, on October 8, by Mr. A. S. Worcester, of Huddersfield, is well up to the interesting and informative standard of previous sessions. The meeting on November 12 will be a free discussion on the question of Iron Castings *versus* Fabricated Parts, the two sides to the debate being opened by Mr. A. W. Walker and Mr. E. B. Shore respectively. This is the first time there has been a set debate from two distinct points of view on these lines. On December 10 Mr. Walter Fearnside, of Shipley—a member of the Branch who always takes a keen part in discussions—is to give a Paper himself on "A Few Foundry Problems," and is certain to introduce some interesting and probably controversial points. The success of the first annual dinner last winter was such as to leave no question about a second, and this is fixed for January 14. On February 11 Mr. Francis Rowe will lecture on "Cause and Effect in the Bronze Industry." The March 11 gathering will be in the nature of a works visit, the particular firm concerned not yet being named. A lecture on "Grey-Iron Castings," given jointly by Messrs. F. K. Neath and F. Poole, will be the subject for April 1, and the session winds up on April 29 by the annual general business meeting and election of officers. All the ordinary meetings, as in previous sessions, are at the Bradford Technical College, beginning at 6.30 on Saturday evenings.

The library of reference works collected by the Branch for the use of members has been increased since last winter. Mr. S. F. Wise and Mr. G. E. Booth are in attendance on the meeting nights from 6 to 6.30 as librarians.

Lancashire Branch, Burnley Section.—The Burnley Section held its opening lecture of the session on Saturday, October 8, at the Municipal College, when Mr. E. Longden read a Paper on "Some Notes from Previous Lectures on Foundry Practice." Owing to the illness of Mr. J. Taylor (the President), the Junior Vice-President (Mr. L. Wharton) took the chair.

Mr. Longden described the methods of running various types of cylinders for gas, oil and steam engines. On lantern slides he showed the various processes in the manufacture of a hydraulic cylinder and ram, of a 7-ton furnace column and of a 60-in. pump body casting. The manufacture of 10-ton slag ladles and lathe bed plates was also illustrated. A particularly good series of slides showed how the nature of the mould material used affects the degree of cavity in the

casting; and emphasised the need for using chills and denseners for reducing cavity. .

A lengthy discussion ensued, and Mr. E. Flower (President of the Lancashire Branch) proposed a vote of thanks to Mr. Longden, which was seconded by Mr. J. Jackson.

Lancashire Junior Section.—Last Saturday, Mr. R. A. Jones, the newly-elected chairman, in his opening address referred to the competition

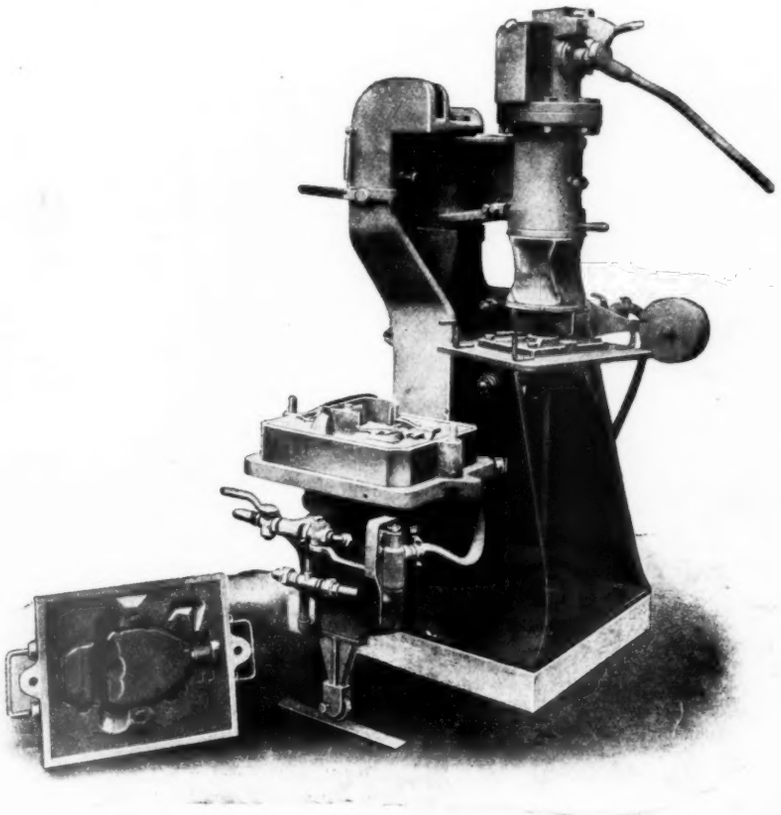


Fig. 5.—The P.W.1 Jolt-Squeeze Turn-over Machine.

Fig. 6.—A New Type of Flask Discharger.

the foundry trade is having from weldings. "At the present time," said Mr. Jones, "we are having much competition from fabricated pieces of machinery, but with the co-operation of the metallurgist and with the ultra-modern methods of melting such as the Sesci and Brackelsberg methods—although they are not as yet an economical proposition for the smaller type of foundries—the iron casting will more than hold its own with these bits of patches and seams. Moreover, and what is more important, the foundryman is always willing to conform to the designs of the engineer, whilst the welder produces some very weird and crude designs." After his address, he presented the medals and prizes which had been gained by the members. The John Wilkinson Memorial Medal was won by the same competitor as last year, Mr. Jack Holmes, the second place was awarded to Alfred Fox and Messrs. L. Gregson, J. Hough and D. Menzies were highly commended. Mr. Jack Holmes also secured the Buchanan Medal. Book prizes were given to B. Haigh and L. Foden, who gained the first and second places in the short-Paper competition.

Mr. George Longden read a Paper, illustrated by lantern slides, on "General Foundry Work."

The Importance of Details.

Many think it a mere platitude to say that small things are really the more important. In effect they are, for the big things are apparent, everybody concerned seems to have a hand in them, the patternmaker goes to the foundry, the foundry manager visits the patternshop; consultations ensue, and all are satisfied. The smaller things, however, often get shelved, and only too often the money lost is out of all proportion to the money saved on the big jobs. Now, why is this? Perhaps it is because of divided control, or on account of insufficient attention. These factors may be the cause, but a great deal of loss is occasioned by natural inobservance of which all are offenders.

If it takes a good man to see what might be improved, it takes even a genius to observe details continually. For instance, you might pass through your foundry every day, yet have you noted the differing traits of the men on their various jobs? What size of headers and

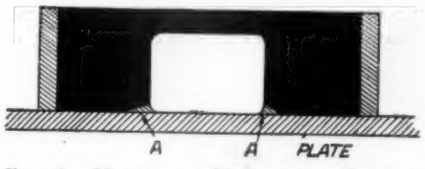


Fig. 1.—Method of Mounting a Pattern using Four Loose Strips.

risers do they make? Do you know? Do you know if they are as small as they might be, and are your men encouraged to make them in relation to the job? Have you ever thought that if you could save an eighth of an inch in the diameter of each one how much less metal you need melt in the course of a year? The average foundry could save melting about 20 tons a year even though only ounces are saved on each header. Another instance of a little foresight which saves minutes only in one operation, but many hours in the course of a year is seen in this small problem of machine moulding. For simplification, the illustration shows only a square block, but the application is widespread, if the corners are rounded. Half an hour's patternmaking will make four loose strips (or one piece if desired), as shown at "A." They are laid on the plate and the pattern also, as shown in Fig. 1. Fill and squeeze in the usual way and turn. Then re-

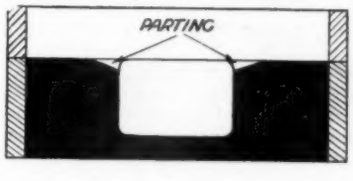


Fig. 2.—The Box turned over for Stripping.

move the strips, put on the parting sand and finish the mould. There is a short time saved in clearing away sand to the bottom of the mould. In the simplest possible application—that of a square block—two minutes are saved, whilst the more complicated the operation the greater the saving.

If a job takes 100 hours and an hour can be saved, the saving looks quite large; on the other hand, if a job takes an hour and one can save two minutes, the saving is even greater, especially if, as so often happens, there are 100 off the small job. In the first case there is a saving only of 1 per cent., whilst in the latter 3½ per cent. If then the examples cited have been appreciated, foundrymen will be more observant when in the foundry, and moreover will realise the great saving effected in the course of time in these only too neglected foundry details.

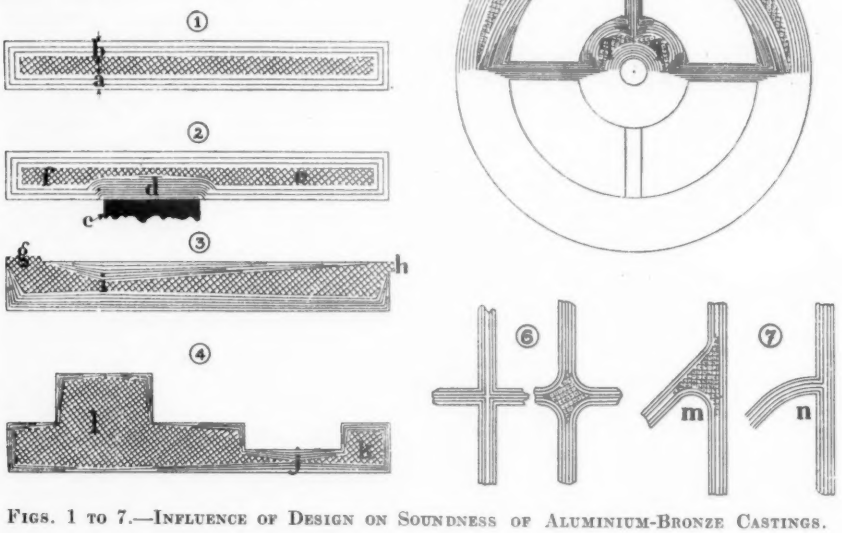
Rational Use of Aluminium Bronze.*

SOLIDIFICATION, HOT WORKING AND INTERNAL STRESSES.

By C. H. Meigh, M.Inst.M.

The use of aluminium bronze, which has developed so quickly during the last few years, needs a rational conception of design which is adaptable to the requirements of a particularly delicate foundry production, if the essential features of its special qualities are to be obtained. The principal points are:—(1) perfect general condition and homogeneity of the metal; (2) maximum mechanical characteristics which range from 38 to 41 tons per sq. in. ultimate stress in sand castings, to 51 tons in chilled castings and forgings; and (3) reduction in the weight of the castings and forgings, usually made in other metals, because of its high tensile strength. This question of weight reduction is paramount in Naval construction work, and enables an appreciable reduction in the cost of material.

It is therefore evident that the time passed in making a design which is really suited to foundry requirements is well spent. The draughtsman's chief object should be the *quality of the metal* rather than *facility for moulding*. The alloys under consideration fall in the $\alpha + \beta$ range of aluminium bronze alloys which are by far the most useful, but for which the preparation, casting and subsequent treatment are the most delicate by far, and the more the difficulties are placed in the foundryman's way by unsuitable designs the less chance he has of producing the best qualities.



Figs. 1 to 7.—Influence of Design on Soundness of Aluminium-Bronze Castings.

The object of these few notes is to draw the draughtsman's attention to the importance of two details in the cast correlated problem of solidification and internal stresses. Two phenomena play an all-important rôle in this problem:—(1) The metal passes from liquid to solid without passing by an intermediate stage; and (2) there is an important internal contraction when the crystals solidify. The first-mentioned phenomenon is of great use and is often employed to counteract the second. Fig. 5 can be taken as an example, where the casting represented is a type of flywheel, formed by thin-sectioned spokes joining up two heavy sections. In this case the sections "o" solidifies, and even starts their lineal contraction before the heavy sections have solidified.

Three advantages are obtained from the above conditions:—(1) The danger of fracture at the junction of the thick and thin sections is eliminated by solidification without an intermediate phase; (2) the thin sections have the effect of chilling fins, and accelerate the solidification of the thick sections in their vicinity "p," which allows the casting to be successfully fed at the points "q," which are most remote from the chilling fins; and (3) the internal stresses can be considered as negligible, as they are, to a great extent, eliminated by the annealing effect of the heavy sections, which keep hot sufficiently long to provide partial if not total equilibrium.

Draws.

In admitting that thin sections can be successfully joined to thick sections, it is interesting to study a few of the causes of draws.

As each crystal solidifies its volume is reduced by about 10 per cent. Or, in other words, solid crystals have only about nine-tenths of their liquid volume, and it is to this natural compression that the high tensile qualities of the metal are attributable. The normal lineal contraction of 1.8 per cent. should be considered as being in addition to the internal contraction. The natural compression of the metal on solidification can be considered as more or less replacing the effect of hot working on metals which solidify with less internal contraction, but the phenomenon renders aluminium bronze very difficult to produce without a defect, and it is necessary that designs be adopted by following definite rules which are easy to apply.

Solidification.

The author considers that these rules can be clearly laid down by the use of theoretical sketches, in which the sequence of solidification is indicated by more or less parallel lines which represent the successive crystal layers which form in accordance with the laws of solidification, and on which the method of casting or moulding plays an important rôle. These observations are the outcome of micrographic examination of a considerable number of castings. The method of illustrating layers of solidification was taken from A. W. and H. Brearley's book on Ingot and Ingot Moulds. The natural solidification of a casting can be illustrated by lines, parallel to the walls of the mould. Gravity has no influence on solidification, that is to say, that if all other elements are constant, the thickness of the top solid layers "b" is the same as those at the bottom "a" of the casting, and *temperature* alone can change these conditions. This is shown in Fig. 1.

Fig. 2 represents the same casting moulded in sand, but with a chill "c" placed at the bottom of the mould. The chill being a good conductor absorbs the heat of the metal and accelerates solidification at its points of contact. The first crystals to solidify are those in direct contact with the chill, and although the lineal contraction may break the contact before the casting is entirely solidified, the crystals which are already solid continue to chill the molten metal in contact with them and complete the effect started by the chill. An exactly opposite effect would be produced by sinking a block of sand into a metallic mould.

In the case represented in Fig. 2 the casting should be fed at "e" and "f," as otherwise internal contraction cavities would be formed in both places. These two places can either be fed by feeder heads placed directly on the casting, or by a canalisation in which the solidification is retarded and which communicates with the feeders. If the same casting is moulded without a chill, and the feeder head is placed directly on the casting at "g," Fig. 3, and if the metal enters the mould at "h," two reheating effects are produced. The first effect is produced at the runner, where the continual flow of hot metal heats the mould, or the first layer of solid crystals, and prevents the solidification of others. This is by far the most important effect. The second effect is produced at the feeder, which being kept hot itself retards solidification in its vicinity by conduction, and by the metal it furnishes to the casting.

The first part of the casting completely to solidify is "i," followed by "g," and completed by "h." In considering Fig. 4, and in neglecting any reheating effects at the runner, it is evident that the solidification would start at "j," continue at "k," and finish at "l." This order of solidification would not be changed by running the casting either at "j" or "k," the section of "l" being too heavy. If, in a casting, there are several heavy sections "l" situated approximately on the same plane, they could be ameliorated by feeding heads, and no draws would occur. In this case, supposing that the smaller section "k" could not be conveniently fed by a feeder, it is sufficiently small to be artificially chilled without inconvenience. But if, in a casting, there is a heavy section "l" which is inaccessible to the feeders, the problem becomes much more complicated and can only be solved in one of two ways.

Alternative Methods.

The better method is to change the design in order to make it possible to feed "l" without artificial means, or, in the case of absolute necessity, to establish profiled chills which cover as far as possible the entire surface of the heavy sections. In the second case the casting will probably not be properly fed, but the cavities which are formed will perhaps be sufficiently far from the surface not to effect the actual utilisation of the casting. Perfect feeding is important, not only to prevent large suction cavities, but also to avoid porous or anæmic zones, all of which represent different stages of insufficient feeding. The intermediate stages of porous metal would not withstand hydraulic pressure, whereas the quality of the metal from the anæmic zones would bear a direct relation to the degree of feeding.

Fig. 6 illustrates the solidification of ribs at their junction of the casting, with and without a radius in the corners. A radius increases the section and thereby retards solidification; it is usually of no other use than to improve the

*A Paper presented to the Paris Foundry Congress. The Author is managing director of Société des Forges et Fonderies d'Alliages de Haute Résistance de Petit-Quevilly (France).

aspect, which is largely a question of custom. In admitting that the complete suppression of the radius might constitute a weak place, it is generally sufficient to make the edge in the mould less sharp. If the pattern is made with a radius in the corners it should be as small as possible.

Fig. 7 illustrates the junction of two walls situated otherwise than at right angles to one another. This type of junction is frequently found in cylinder water jackets, and the current practice is to follow the profile "m," but the extra thickness thus formed retards solidification and suction cavities are produced. On the other hand, if the junction is formed by following the profile "n" the solidification is not retarded and the casting can be properly fed. By following the principles described above and with the able assistance of the French marine engineers, the author has realised a reduction in weight of 40 to 60 per cent. on such material as marine stop valves; plug cocks, full way slide valves, etc., which had been made hitherto in the 88-12 copper-tin alloy, while the factor of safety was either unchanged or increased.

This result shows that the weight of a quantity of different material can be reduced by the use of high tensile non-corrodible alloys with greater security than by the use of light alloys which are more or less corrodible. Perfection in aluminium-bronze material can only be obtained by the close collaboration of the user, the designer, and the foundry, and the experience acquired on previous work allows a continual extension to be made in the range of applications of the metal. There should be no hesitation in changing patterns and designs which have been made for other metals, as the outlay is rapidly repaid.

Hot Working and Internal Stresses.

In mechanical construction work a draughtsman is often called upon to choose between cast or wrought metal, and his wish to give maximum safety often inclines him towards wrought metal, as tradition postulates that castings are defective while forgings are sound. Perhaps there was some foundation for such opinions where steel was concerned, as defects in the ingot might be welded during the working, and the forged material might have been better than the cast. But what is true for one metal is necessarily applicable to another, and in the great majority of cases material cast in aluminium-bronze is sounder and cheaper than if it were produced by forging, stamping, or other methods of hot working or work hardening.

In the first place, hot working does not improve properties of aluminium-bronze other than the *elongation* which in the cast state is more than satisfactory. In other words, micrographical control will reveal a reduction in crystal size without changing the all-important grain-size. Very high tensile strength is found in light wrought sections, principally caused by a partial quench or the effects of work hardening at a low temperature, but equal if not superior properties, with corresponding microstructures are to be found in similar sections in the cast state. Light sections in chilled castings normally give an ultimate stress of 51 tons per sq. in., and the minimum given by any section, either sand or chill cast, is 38 tons. These figures apply to the core of the metal just as well to the shell.

On the other hand, in wrought material, and above all in heavy sections, a test-piece taken from the centre of a block of metal would not give the same result as one taken from the surface of the same block, and neither the one nor the other would give a result approaching that found if a part of the same block were reduced to ¾ in. dia., for example. These three results would bear fairly constant relations to one another as far as similar sections are concerned, but the small ¾-in. bar would give at least a 20 per cent. higher ultimate stress than the average of the other results obtained in the heavy sections. The improvement in the small section is either due to a partial quench or to work hardening at a low temperature, or perhaps a combination of both, but the improvement should in no way be attributed to the effect of working at a high temperature.

The transformation points in the different aluminium-bronze alloys vary according to the chemical composition of the alloy, but it can be considered that one is situated between 490 and 560 deg. C. and the other between 740 and 906 deg. C. If an alloy be studied, the transformation points of which are at 500 and 800 deg. C., it can be considered that work done at a temperature above 800 deg. C. improves nothing but the elongation, effect which is characterised micrographically by the lengthening of the α and β constituents in the longitudinal section of the work. Between 500 and 800 deg. C. there is a point where work-hardening commences, which causes the fragmentation of structure and a corresponding increase in yield point and ultimate stress.

The heavy sections, however, cannot be worked to the core of the metal at these low temperatures, and the effect of working is more or less superficial, a condition which creates internal stresses in the metal. The degree of work-hardening produced by a given deformation depends on both the speed at which the metal is deformed and on the temperature at which the work is done. The slower the deformation speed, or the higher the temperature at which deformation occurs, the less the effect of work-hardening is visible after a given amount of deformation.

Consequently, hot-working in aluminium-bronze should only be considered as a method of producing sections which cannot easily be cast, such as bars which are long or wide in comparison with their thickness, but when material can be cast its quality is as good, if not better, than when it is in the wrought state. Aluminium-bronze does not weld when forged, and the advantages obtained from hot-working are negligible. But, on the other hand, other effects caused by the hot-working under bad conditions are far from being negligible. A comparison between cast and wrought material, from the point of view of possible defects, is interesting. All defects which existed in the ingot will exist in the wrought material, but working done under bad conditions reduces the quality still more, and can even transform a good ingot into a defective bar.

Examples of Defects in Wrought Material.

Overheating.—An ingot or wrought material heated to almost melting point is deteriorated. If it is attempted to forge such metal it would either break or crack. In that case there is not too much harm done, as the object is immediately scrapped. But if, after it has been overheated, the metal is allowed to cool down before it is worked, the defects may not be visible on the surface, but the intercrystalline cement being deteriorated, the metal is rendered fragile, and the fragility may only be local, and a test-piece taken from outside the deteriorated locality would give a normal result. Invisible defects produced by accidents of this kind are the most dangerous, and their detection is very difficult, although deteriorated metal is characterised in its microstructure by intercrystalline cement formed of concentrated σ bordered by β.

Bad Working Conditions.—A good ingot which is badly forged, so that there is crystal slip without differentiation, would deteriorate the metal and finish by either producing cracks or a hollow centre, also difficult to detect. A similar, but less dangerous result, is obtained by work hardening a surface of the metal and leaving the centre in a more or less annealed state. The conclusion is that the advantages gained from working the metal do not justify the risks which are run, as they are liable to deteriorate it by bad working or over-heating.

Before concluding these notes, the question of internal stresses in cast and wrought material will be examined. Theoretically, internal stresses exist in any piece of metal which has structures of varying fragmentation. That is to say, in any casting or forging which has not been annealed. But speaking from a purely practical standpoint, the internal stresses, which do not deform the metal when a considerable thickness has been removed by machining, can be considered as negligible. The degree of internal stress can be easily determined by examining the change in structure between two relatively close points in the same piece of metal.

Influencing Factors.

The principal influencing factors are:—(1) *Chill.*—From liquid to solid, from a high temperature in the solid state to a much lower temperature and total chill and (2) *Work Hardening.*—At low temperature or cold. As a general rule, stresses which are produced by the difference in the speed of solidification can be considered as negligible, in the majority of cases, as they occur at a sufficiently high temperature to induce self-annealing.

The structure in the middle of the thin sections of Fig. 5 would be totally different from that in the heavy parts, but as the extremities of the thin sections are annealed by the heavy sections, the change in structure is very gradual, and the stresses can be considered as non-existent. If, on the other hand, these same forms had been produced by stamping, the temperature at the end of the working would not have been sufficiently high to allow of self-annealing. There would be important stresses with the characteristic changes of structure.

The conclusion is that stresses produced only at high temperatures can dissipate themselves adequately and thereby eliminate annealing—a supplementary operation which increases the cost of production and the risk of accident. All these questions should be considered before making a decision concerning the method of production of material in aluminium-bronze. The methods which entail the minimum of operations and treatments will generally give most satisfaction and prove to be the most economical. It is hoped that these few suggestions will render service to users of aluminium-bronze, and, if followed in conjunction with correct foundry practice, will produce sound material which will give every satisfaction.

New Magnet Steels.

A new series of magnet steels has been perfected by Dr. T. Mishima, an assistant professor of the Tokio Imperial University of Tokio, Japan. These new magnet steels are called "MK steel" and are characterised by a very high order of permanence. The coercive force is claimed to be about nine times that of the usual tungsten magnet steels and two and one-half times that of the best cobalt magnet steels. The residual magnetism ("magnetic strength") can be varied so that its value is between that of tungsten and cobalt magnet steels.

The MK steels consist mainly of iron, nickel and aluminium. A typical composition is 25 per cent. nickel, 10 per cent. aluminium, balance iron, but the nickel may be varied from 10 to 40 per cent. and the aluminium from 1 to 20 per cent. These steels are not readily forged and must, therefore, be cast into the desired form. However, their desirable magnetic properties are developed by simple annealing and they are therefore free from the difficulties of quenching which is required with the tungsten steels.

In addition, it is claimed that the magnetic properties of the MK steels do not change appreciably with increase in temperature even to the extent of several hundred deg. C. They are also said to be stable, magnetically, when subjected to mechanical vibration or shocks.

XUM

Chaplets.

By William F. Chubb, B.Sc.

The use of chaplets as supports for cores is a long-established practice and while present methods of casting are maintained is one that cannot readily be dispensed with. The choice of chaplet materials for any particular casting is one, therefore, which requires careful consideration, more perhaps than is either thought necessary or even commonly given. Yet not a few failures and rejections of castings, particularly those requiring much coring, can be ascribed to incomplete attention to this subject. In this connection the author has brought to mind failures from core shifting and from local leakages in castings which are subjected to water tests or which are required like motor-car cylinders to remain gas-tight. In a large number of instances of failure under these tests investigations lead to the conviction that quite apart from the question of chaplet design in relation to its particular use the choice of materials from which they are made and considerations of surface finish are not always given the attention they deserve. The view is commonly held among users, and more particularly among the practical foundrymen, that the main consideration in choosing chaplet materials is that of strength and rigidity to hold the core firmly and prevent flotation during pouring of the molten metal. This, indeed, is the special purpose of the chaplet, yet further thought will show that it is by no means the only desired property. It must also form a close union with the metal when cold and also show no loosening during trimming of the casting. The mechanism of fusion, indeed, seems but imperfectly understood and it seems desirable to explain what happens to the chaplet while immersed in the cooling metal. In this manner changes brought about by alterations in casting conditions can then more readily be anticipated and rejections from these causes reduced to a minimum.

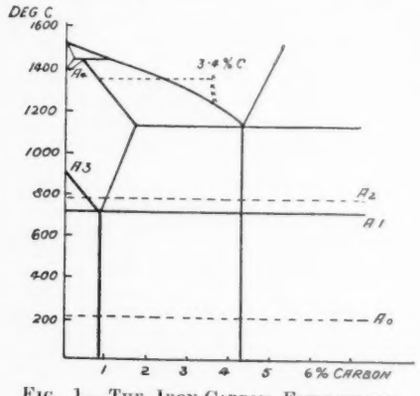


Fig. 1.—The Iron-Carbon Equilibrium Diagram as affecting the Function of Chaplets.

Mechanism of Fusion.

To illustrate these changes it is necessary to consider a suitable example, as, for instance, in the production of grey cast-iron castings. Chaplets for this purpose are made chiefly from wrought iron as being the cheapest material available. Any low-carbon iron will, of course, be found quite suitable, provided that it has the desired physical properties. Wrought iron, however, displays considerable variations in composition and chemical analyses indicate a very wide range in chaplets drawn even from the same supplier. This is not difficult to understand when it is realised that wrought iron may have a varied composition due to many factors quite outside the control of the chaplet maker, who invariably is not the maker of the material. For example, the carbon content may be as high as 0.25 per cent. or even lower than 0.05 per cent., while other elements such as manganese, sulphur, phosphorus, may be present in equally variable proportions. All these factors will, of course, influence the mechanical and physical properties and reference to test results will indicate the wide range of both tensility and ductility which may result. This is but one influence of chemical variation and heterogeneity, and another, and perhaps more important one in this connection, is that of relationship between fusion point and composition. This property comes into prominence in considering the fusion between chaplet and molten metal which must take place in the instances quoted to ensure watertight castings being supplied to the machine shops.

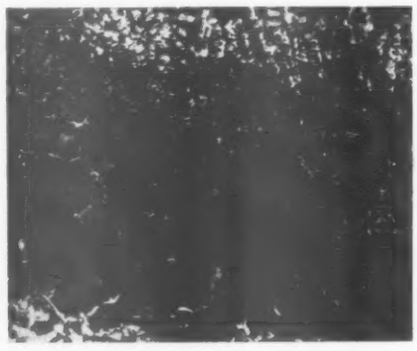


Fig. 2. shows the Function between a Wrought-Iron Chaplet in a Leaking Motor Cylinder Head. × 80 Dias.

The mechanism of fusion in chaplet materials when surrounded by molten metal which is solidifying at a relatively rapid rate is best understood by reference to the iron-carbon equilibrium diagram and to a typical wrought iron of, say, 0.05 per cent. carbon, and for this purpose Fig. 1 gives that portion of the equilibrium diagram to be considered. In its molten condition a typical grey iron of approximately 3.4 per cent. carbon will contain all its carbon in the combined form in solid solution. When immersed in molten cast iron the chaplet material will absorb carbon and the surface-carbon content will rise progressively to a high figure. At the same time its fusion point will be lowered and if the surrounding metal remains molten for a sufficient length of time the surface will fuse with the melt when its carbon content has reached that composition corresponding to the temperature of the molten metal. For example, a chaplet surrounded by metal containing 3.4 per cent. of carbon at a temperature of 1,350 deg. C. must carburise to the extent of approximately 2 per cent. before fusion can take place, but in metal of higher temperature not only will carburisation be more rapid but the extent of carburising required to effect fusion between chaplet and melt will be correspondingly lower. It will be observed also that if for some reason carburising does not take place, fusion between the two will be impossible unless the cast iron be held at the fusion point of iron containing 0.05 per cent. of carbon, approximately 1,500 deg. C., a temperature too high to produce sound and close-grained castings. It will also be clear from the equilibrium diagram that because the casting metal is continuously cooling and in consequence its composition progressively altering down to the eutectic temperature of 1,134 deg. C., so must increased surface carburisation in the chaplet become necessary in order that fusion at lower temperatures should take place. Hence it is to be expected that when insufficient time is allowed for full carburising to occur, as, for example, in the cooling of thin sections or of metal poured at a too low temperature, then at best incomplete fusion with the melt will take place. That a condition such as this may arise occasionally in practice is the author's experience and is illustrated in Fig. 2. This photomicrograph at a magnification of 80 shows the junction between a wrought-iron chaplet in a leaking motor cylinder-head cast too cold. The production of excessive free cementite in the casting metal, as well as the very small degree of carburisation in the wrought-iron chaplet are at once clear and have resulted in incomplete fusion between the two, as well as cavities in the cast iron in the region of the junction.

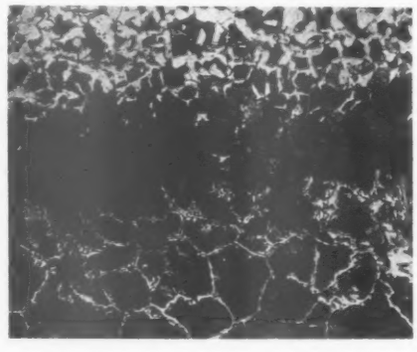


Fig. 3 shows a More Highly-Carburised Surface due to Higher Casting Temperature. × 80 Dias.

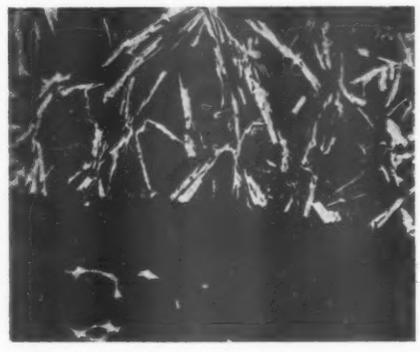


Fig. 4 shows the Function of a Properly-Fused Chaplet. × 120 Dias.

At the same magnification, Fig. 3 illustrates the very much more highly-carburised surface resulting from a higher casting temperature, and Fig. 4, at a magnification of 120, represents the junction of a properly-fused chaplet. Here the high-carbon content has resulted in the formation of massive cementite which is undissociated on account of the low silicon in the wrought-iron material. The surface carbon content is as high as would be expected under the normal conditions of casting, the surrounding metal is uniformly grey and of fine-grained structure, and fusion between the two is complete. These photomicrographs afford clear indications of failures resulting from imperfect welding at the surface of the chaplet and by reference to the mechanism of fusion the underlying causes are at once apparent.

Cleanliness.

Whilst a large number of leakages and unsoundness can be attributed to the causes outlined above, a further important factor govern-

(*Concluded on page* 242.)

Jobbing Foundries a Specialised Trade.

MR. BIGG'S PRESIDENTIAL ADDRESS.

The East Midlands Branch of the I.B.F. opened its Winter Session on Saturday, September 24, at the University College, Nottingham. The retiring President (Mr. T. Spiers) welcomed the visitors present and introduced his successor in the chair, Mr. C. W. Bigg, of Derby, who gave his presidential address.

Presidential Address.

The members of the Institute of British Foundrymen may well be proud of what this association has so far achieved in its endeavour to improve the status and increase the value of the foundry and the foundryman to themselves and to industry in general, but at this, the commencement of another session, it may be well for us, as a Branch, to remind ourselves of the necessity that those endeavours be maintained, commensurate with the growth of our task. Foundrymen are unanimously convinced that there is no trade with more problems than the castings industry. Those outside the foundry might not subscribe to this opinion, but let those within maintain it as a constant incentive to effort, directed towards the solution of their problems, the increasing of their efficiency and the expansion of their industry.

The Immediate Past-President (Mr. Harley), in a recent reference to the work of the Institute, expressed the hope that in such work its members may learn something of the art of living as well as the art of making castings. Many foundrymen are convinced that to make a bare living from the industry is their biggest problem. Possibly it is, but that type of argument simply revolves round the £ s. d. price of everything in the lowest possible terms.

The Institute very rightly excludes such arguments from its proceedings, but if foundrymen solve the problems which the Institute does admit in its discussions the price factor will not have such a depressing effect as it now seems to do. The solution of these problems will teach them, and those industries for which they work, that what a man, what a material, what a machine, what a method will produce, is the factor eventually controlling what we or they can afford to pay for it.

One does fully realise that the many adverse circumstances which have surrounded the foundry industry for some years have made it extremely difficult for the present generation radically to reform the conditions which they inherited, and one also realises that tremendous strides have recently been made, yet there is still evidence that the £ s. d. of first cost is still the predominant factor in much that concerns the industry. It is the £ s. d. of the last cost which is the touchstone upon which the ultimate judgment will rest.

There has recently been a suggestion that greater efforts should be made to convince industry in general of the wider use to which castings can be put, a most valuable suggestion. Let us by all means advertise the value of our products as much as possible. We want to convince all and sundry of the potentialities of our products in order to create an increased demand for such products, and there are signs that the engineer can be so convinced, but then arises one of our big problems. The serious lack of understanding between the engineering designer and our industry has been frequently commented upon. The increased demand which a wider application of castings brings will not be an unmixed blessing unless that lack of understanding be remedied. The foundry industry must show not only the desire, but also the ability for an intelligent co-operation which will result in that better understanding. It is our province so to guide and instruct that increased demand for which we hope—not with a view to restricting the specifications in such demand or of making it easy of fulfilment—but rather that the demand shall be such as will call upon the highest efficiency in the industry to produce, and that, in meeting it, we shall stake a claim for castings in industry such as will ensure the prosperity we desire.

A Metamorphosis.

Foundrymen have already left behind them the days when some few tons of sand, a hollow cylinder of uncertain dimensions, housed in a tin shed, all drafts and no ventilation, with a personnel of the cheapest and least-educated type, could be considered as typical of the foundry. Rule of thumb is being replaced by methods based on the results of scientific investigation. Some attention is being paid to the design and construction of foundry buildings conducive of efficiency, not only from the point of view of production, but also with a view to the comfort and well-being of the workers. The growth of metallurgical knowledge has been truly amazing, and the foundry laboratory is now the rule rather than the exception. Much consideration is now being given to the mechanisation of our industry. Man-handling has been too prominent a feature of the foundry for many years, and for the good of all concerned it is desirable to eliminate this as much as possible. But let not the foundryman accept the idea that with the purchase of a certain amount of mechanical plant he is assured of a cessation of his trouble and a short cut to prosperity. With the purchase of that plant must be the realisation that the suitability of it, and of the successful working of it, is the problem and responsibility of the buyer and not of the seller of such plant.

The Jobbing Foundry as a Specialised Trade.

Even the most specialist amongst foundries covers a wide range of work, and an unwise selection of mechanical plant can very easily result in a considerable limitation of that range. Doubtless a greater development of specialisation on particular types of castings, by particular foundries, can be looked for as a result of mechanisation, but, as an industry, we ought to become specialists, not as an accidental effect of mechanisation, but as a studied result of organisation. The jobbing founder should be as great a specialist, as a jobbing founder, as is the repetition or mass-production man. The increase of mechanical plant is calling for a different attitude from those in control of the foundry. Whereas it was very largely the custom to hand the pattern, such as it was, to the moulder with the simple instruction, "So many off this by Friday," now there is much to be done before the moulder touches the job, and it is no exaggeration to say that so far as very much foundry work is concerned, the pattern shop, laboratory, etc., have taken, and are taking, the place of the man on the floor to an increasing extent. We know that many moulders are convinced that there is room for a greater appreciation and understanding of what may be termed "floor problems" by these other departments mentioned, and in this opinion the moulder is undoubtedly right. With the changing conditions, an efficient patternmaker must have a very different outlook towards the foundry floor than used to be the case. One of the old sayings in the foundry is, that the man who cannot make wasters cannot make good castings. We shall always have wasters, but what we must aspire to is the development of the foundry executive, who, from the drawings and specifications, can so plan and lay out the work so as to produce good castings without going through the expensive process of making wasters as a preliminary. There has got to be more real management in the foundry than has existed previously.

The £ s. d. of the Last Cost is the Real Test.

Do we generally realise what an important factor among the essentials for efficiency a proper costing system is, and how necessary it is that such a system should not only exist, but should be understood, and in constant use by those in charge? For the ultimate satisfactory result an efficient costing system is vital. A costing system does not make castings, but it records results and, properly used and interpreted, can govern results. Much of the costing in the industry is too general, too infrequent, and too little understood by those to whom it applies. I have heard of costing once yearly. I know firms where it is considered sufficient to have a cost analysis every three months. To have a review of your costs monthly gives you a chance to see the trend of your expenses and make adjustments, but a weekly summary enables you to exercise control. Competition is keen. Keen competition without proper costing spells disaster for the individual and dissatisfaction for the industry.

No matter from what point of view it is examined, the foundry is becoming a different place from what we once knew it to be. It is demanding a more intelligent and comprehensive outlook, both from those working in it and from those for whom it works. On us lies the responsibility for the outlook of those outside, and this will react to our benefit only if we prove ourselves efficient and capable of taking advantage of the opportunities that present themselves.

The New Personnel.

To meet the much-to-be-desired expansion of our industry, we must be prepared with capabilities for expansion of our equipment and personnel. The personnel is the more important than the equipment. Granted the one, the other will follow. An expansion of any industry means the expansion of those in the industry. Many times in the past have we been told that the foundry does not attract the best men, and of the past this was unfortunately partly true, but unless we make it wholly untrue, there is little hope for us. No industry finds its personnel ready made. As with its products, it has to take the raw material and fashion it into the finished article, and a large part of our task lies in seeing that adequate and efficient means are to hand for the education of the actual and potential foundrymen. We can boast to-day of having in our ranks some of the best men in industry, but we have to ensure a succession of foundrymen such as will maintain our industry's prestige in the work of the world.

In the Institute and amongst its activities we have an excellent medium for the discussion of our problems and the expression of our opinions, and we, as a Branch, can look back with a deal of satisfaction to our contributions in the past to the success of the Institute, and I trust that the coming session will be as productive of interest as its predecessors.

Mr. Bigg expressed regret that one of the Past-Presidents of the Branch, Mr. Thomas Goodwin, was lying seriously ill in Derbyshire Royal Infirmary. It was resolved that the secretary should write Mr. Goodwin expressing the wishes of the meeting for a speedy recovery.

Mr. Bigg then called upon Mr. V. C. Faulkner (Past-President of the Institute) to deliver his Paper on "Technical Education and the necessity of a College for Foundrymen."*

The Chairman thanked Mr. Faulkner for his address and put the matter to the meeting for open discussion.

Mr. T. Spiers, opening the discussion, said he had entertained the idea of a special foundry college for some time past, and to his mind the matter was becoming urgent. There were all sorts of colleges for the training of engineers and those engaged in other spheres of industry, and

* Foundry Trade Journal, October 6, 1932, p. 199.

if it were necessary for them, how much more for the man who had to control the engineer and patternmaker as well as his own personnel. The foundry was in more need of a college than any other industry. There should be a residential college where there can be provision not only for work, but also for play, to make not only the craftsman, but also the *man*. His idea was that no one should enter the college unless he had the necessary qualifications, apart from the paying of the fees. The purely academical influence must be kept as far as possible in the background. A boy should not be debarred because his parents could not afford to pay the fees. It was definitely time some move was made.

Mr. Lucas said mention had been made of "the complete foundryman." What was meant by that term?

Mr. Faulkner defined "the complete foundryman" as "a person versed in the theory and practice of making every type of casting, from the smallest to the largest, in every type of metal and alloy."

Mr. Orme said the scheme outlined by Mr. Faulkner was too extensive for the training of the foundry apprentice. For a boy to absorb all the factors mentioned would fully occupy the time of the boy up to 22 or 23 years of age. At the present time, a foundry employing several boys, at wages up to £30 per year, must look for some return from the production of those boys. If their time were spent in education, their wages would become an added overhead expense on the foundry costing. He did not think such a vast training was necessary to-day. It was growing practice to install machinery for the production of many types of casting, and while the apprentice was spending time and money in education, his wage was much lower than an unskilled boy on a moulding machine.

Mr. Faulkner replied that the discussion was not on the training of practical men. This was a scheme for the training of the men for the executive positions in the industry. The training of the executive was a necessity. Mr. Fox had recently said this type of man was not available in this country. Who is to make the metal patterns for use with the moulding machines? Such a man must always be a high-grade foundry technologist. To Mr. Spiers, he would say he did not agree that boys should go to the college for nothing. There had been far too much of this "something for nothing" recently. Let them work for it and it will be appreciated. As regards the cost of the scheme, it would be subsidised. All education was bound to be subsidised.

Mr. Bunting thought the idea of a college for foundrymen was an "ideal." One had an ideal and had to work up to it before one got it. It would take years before this ideal could be brought into operation. First, by working from the local technical classes and building up from them suitable individuals to go to the college. There was not a large number of the men in executive positions in the foundries to-day of sufficient education to be benefited from attendance at such a college. Founders must foster the classes in the technical schools. Remarks had been made of the staffs of the technical schools and the question arises as to whether there are available sufficient men capable of giving adequate instruction to students. As an institute, it should see that schools were supplied with teachers capable of giving the necessary knowledge. Until that was done, the proposed foundry college could not be a success.

Mr. Spiers said he had not intended to covet the "something for nothing" idea. Any lad entering the college would have to go there by qualification, and that could not be attained without working for it.

Mr. Lucas thought it a very vexed question. Was there not far too many small foundries? A student would be at the college for 5 or 6 years, and when he left would want a position with a fair salary. To his mind there would not be enough foundries of large enough capital to pay for all their students to go to the college. He could not agree with the remark made that 50 per cent. of the present foundrymen lacked the necessary education. He thought it proved, otherwise how had they reached to the positions they held. He would like Mr. Faulkner to say how long the Paris school had been running, and what results had been attained. Did Mr. Faulkner find any definite results from the Paris school?

Mr. Faulkner said the Paris school was started in January, 1924. During the 8 years they had turned out 22 successful men. They had students of all nationalities. They had placed 22 men in good positions in the Army and Navy Departments and in the larger works. It takes some 3 years' training to turn out these men. There were other students who had experience in other spheres who could take the training for a year or two and could be relied upon to be good foundrymen. Normally it should take 3 or 4 years to turn out a high-grade foundryman.

Mr. Hillman said 4 years was no where near enough to find the smallest part of a moulder's knowledge.

Mr. Faulkner replied that one could always buy purely practical men for £5 per week. The school envisaged was for the training of managers and foundry owners.

Mr. Sherriff: Could not the present technical colleges be utilised? The question of the proposed college would be the locality and the travelling distance from all parts of the country.

Mr. Faulkner said that was what he had said, but his idea was to get all the brains under one roof. Such a college would have a great advertising value and would attract students from all over the world.

Mr. Hillman said that, as a foundry institute, one liked to think one could train these men, but it must be recognised that there is a dearth of good men. He was in favour of Mr. Spier's proposition. It was needed that the better-class lad should come into the foundries. Foundries to-day were being better laid out, but what was wanted was a school for training the boys in the jobbing shops. It did not require a technically-trained man in the mass-production shop.

Prof. Bulleid (Principal of Engineering, Nottingham University College) agreed that one college was needed for the training of the executive. If all technical colleges tried to do it there would be more men than could be absorbed. The technical colleges were not the places for training the moulder. The proposed foundry college would be for training the foundry executive. It may be that the local classes would feed the college. Foundry work was practical work. The man must have practical and theoretical training. How could the practical and theoretical training be combined? He had many engineering students who had a secondary school education. They attended college for three or four years and at about 21 years of age they had to acquire the practical knowledge, and that was bad policy. What he wanted to point out was that a college-trained man of 21 years of age had to have the practical work for a year or two before he was fitted for the executive position. What was wanted was the practical training sandwiched in with the college course. A good suggestion was to put in some foundry work before entering the college, or alternative courses of theory and practice. There was a curious point; the practical foundry in the college became less important and the plant needed was not so costly. Would the scheme be workable? Would foundries be willing to employ students for, say, six months on and six months off? That was what was needed. If the industry would not do that, the college should not be started.

Mr. Walter (Principal of Lincoln Technical College) said Prof. Bulleid had stated the case perfectly. The saving on plant and equipment would be tremendous. Another point that must be looked into early was the cost and how much money was at the disposal of the college. A census of the number of students should be made. It was of no use to turn out more than was required.

Mr. Faulkner said that Mr. Bunting has said the ordinary colleges would supply teachers for the foundry college, but he thought the proposed foundry college would supply teachers for the rest of the country.

Mr. Spiers said when he suggested boys of qualification to go to the foundry college he meant boys of 18 or 19 years of age, who had 3 or 4 years' training.

Mr. Radford thought that until that remark that Mr. Spiers had a different scheme, but he now felt Mr. Spiers and Mr. Faulkner were on the same platform.

Mr. Kershaw (Principal, Leicester Technical College) said there was a difference in the kind of training in France and England. In England a boy may start in the lowest rank and if he had ability he could get help. In France it was different. That accounted for the difference between Mr. Spiers and Mr. Faulkner. They could be on the same platform in England, but not in France. It was possible to have a gathering of the people who had started in the technical schools and only a few would come out successfully and it would be a costly business. It would want considerable help from the industry. He thought it could be done, provided foundry owners would let the boys off in the day time. The owners would say so, but the foundry foreman would not agree. He had found it very difficult to get practical men to talk to and be "shot at" by students. It was often true that if one drew up a syllabus for a year's training, the practical man would go through it in a month. He had often wondered how such men were trained. He had heard several of the Institute's lectures, and they were excellent; how were they produced?

Mr. Faulkner said that in France it was definitely impossible for a workman to get beyond a foreman's position. The French were making a really serious effort, with the help of the Employers' Federation. He had read of men travelling and sleeping on the trains weekly to attend a special course of foundry lectures for operatives. If the Frenchman was prepared to work hard he could get invariably a position as a charge-hand or foreman. The success of the French school was due to the help of the employers, and we should do nothing here without similar assistance. A foundry school was a distinct advertisement to its country of origin, and if we could get the course of 6 months' practical and 6 months' theoretical training we too should get students from all over the world. If the important employers could be interested, then for a modicum of cost the scheme could be started.

Mr. Walters moved a resolution, seconded by Mr. Beck, that "this Branch was of opinion that steps should be taken to form a committee of the General Council of the Institute to examine the question officially."

Vote of Thanks.

Mr. Feasey (Lincoln) had much pleasure in proposing a vote of thanks to the lecturer. The suggestion in the Paper met a felt need. He agreed that the technical schools should do more than at present. Boys should attend of their own initiative, he did not believe in forced attendance. Mr. Sanders, seconding, said the Paper had been thoroughly ventilated in discussion. The course suggested was very extensive, but it was necessary for the foundry manager.

Mr. Faulkner expressed his thanks to the meeting for the attention and discussion given. He thought the reason the question had not been previously brought up in General Council, was that the Education Committee had been so busy on the Trade and National Certificate schemes.

The Mechanical Preparation and Handling of Sand in Non-Repetition Foundries.*

By Robert Macnab.

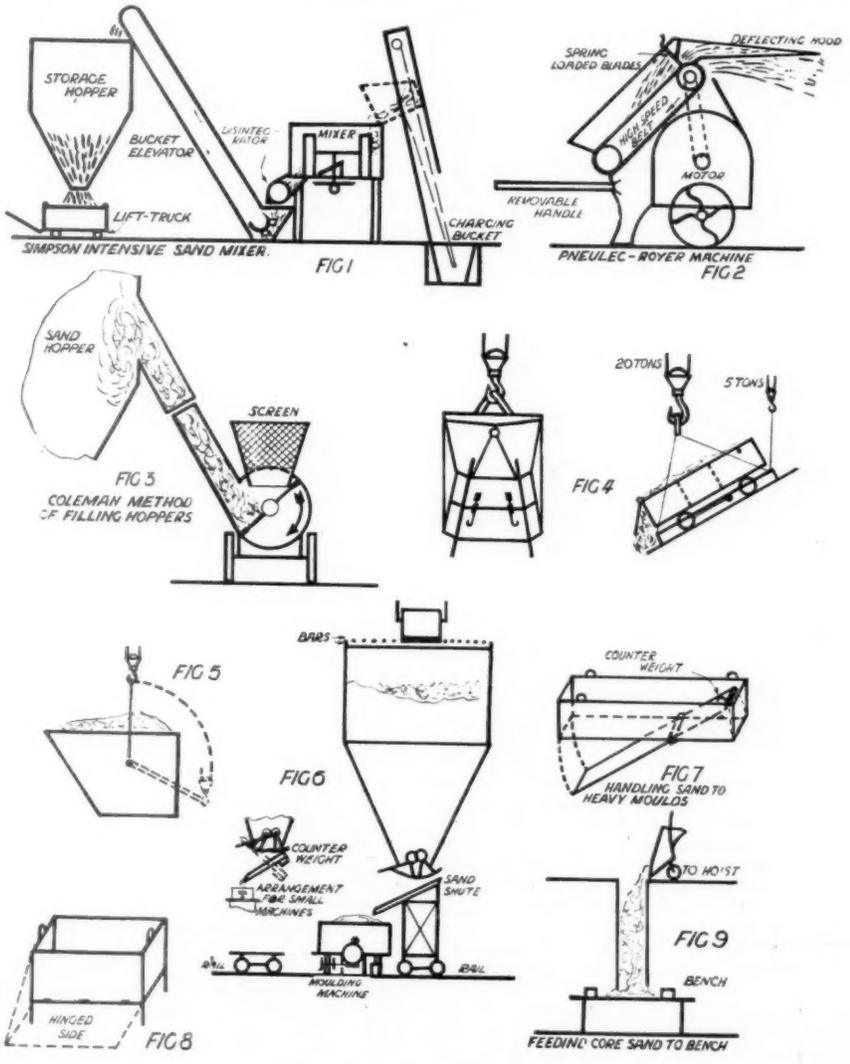
Mr. Evan J. Ross, in introducing the Paper, said Mr. Macnab, who is now in Singapore, was awarded the John Surtees Gold Medal in 1932 for this work, and no doubt the proud possession of such a high award will give him a feeling of confidence which will assist him in his work in future years.

To what extent the methods employed in quantity-production foundries can be applied to the less-specialised branches of the trade is not an easy problem to solve. There are many foundries, equipped with the minimum of plant, apparently able to compete with companies which have installed modern machinery; however, when trade improves, progressive companies will have an advantage over their more conservative neighbours. Increased turnover, with the attendant drop in unit overhead charges, proves the advantages of modern methods.

Whilst it is often remarked that those who install an entirely new plant have a comparatively easy task, possibly the enterprising company with an existing but not inconvenient foundry has a certain advantage, in that mechanisation can be carried out in stages, and a halt called when it is found that the limit of practicability has been reached.

Although there are many reasons for replacing human labour by machinery, this is generally done either to improve the quality of the product or to reduce costs. The preparation of sand by mechanical means may be done to improve the quality of the sand (and probably the casting) resulting in higher market prices or an advantage over competitors. Thus the total benefits gained may be greater than the rather obvious one of the time difference between hand and mechanical methods.

Sand handling is a different problem, for it is obvious that the means adopted to perform this operation cannot influence quality, and therefore a saving in time, sufficient to cover the interest on the capital involved, must be forthcoming.



Figs. 1 to 9.—Illustrate Methods available for Handling Sand in Non-Quantity-Production Foundries.

* A Paper read before the Scottish Section of the Institute of British Foundrymen, Mr. H. D. Campbell presiding. For this Paper the author received the John Surtees Gold Medal.

Preparation of Sand.

There is a large number of sand-preparing machines on the market; undoubtedly different conditions demand different methods, but one is still left wondering how it is possible for all the mixers and mills to find a profitable market. A glance over the pages of the technical Press reveals advertisements extolling the merits of mechanical riddles, rotary screens, vibratory screens, paddle mixers, mortar mills (with either heavy or light rollers), ball mills, centrifugal disintegrators, belt-type and blade-type aerators. There are others which are more difficult to classify, and for one and all is claimed an all-round performance. Again, there are various machines which incorporate the features of two or more of these types in a single unit.

Requirements of a Foundry Sand.—In the first place, the sand must be strong enough to form a mould or core capable of withstanding the physical shocks to which it will be subjected in the process of moulding and pouring. It must be sufficiently refractory to withstand the high temperatures of the molten metal and of a texture which will produce a skin of the desired smoothness on the casting. Lastly, but by no means least in importance, the sand must be permeable to allow free egress of all gases present at the time of casting.

Few sands in the virgin state possess all the desirable properties, and even if they did economy demands the use of a large proportion of old sands in the mixtures. Therefore, the ideal preparing machine would produce a sand in which no excess of binder was present, and accomplish this without reducing the original grain size.

Roller Mixers.

With the exception of the riddle, the pan mill was probably the first mixer introduced into the foundry. In the past it has done very useful work, and, with a careful operator, it is capable of producing excellent sand. An inherent difficulty is the danger of crushing the sand grains by the weight of the rollers. This, of course, would destroy the permeability of the sand. Another trouble is the caking of the sand on the bottom of the pan, which, to some extent, is overcome by the use of a cogged roller, and in this form the mill is still used in a great many foundries.

Machinery should always be as simple as possible to operate, and, of recent years, a successor has been taking the place of the old-fashioned mill. This type has either one or two light rollers which do not ride on the bottom of the pan, and which can be adjusted to vary the space between the rollers and the bottom. Accompanying these are ploughs which constantly turn the sand into the path of the roller, and prevent it from sticking on the bottom. There are various types of these mixers all with different features to recommend them. A notable example which has become very popular is the Simpon intensive sand mixer (Fig. 1) which is semi-automatic in operation. Sand is loaded into a bucket at floor level, a clutch is engaged and the bucket is elevated, and the charge tipped into the mill. This machine does its job very quickly and, moreover, it does not readily spoil a sand which is left in too long. The discharging is also done without any labour, and the sand passes through a disintegrator. This is an optional fixture and it is found that it is not required for oil sands which show no tendency to cake.

Other Mixers.

Riddles and screens are often used in conjunction with some other mixer, and they are very useful for removing stones and scrap from the sand; in some foundries, however, they are the sole means of preparing sand and the inefficiency of this method is revealed by the excessive quantities of new sand consumed.

Paddle mixers are very efficient, and it is a great point in their favour that it is difficult to

spoil a sand by over treatment. For oil sands they are very good, but unfortunately, because of their construction, they clog up easily and are difficult to clean.

A useful unit is the centrifugal mixer, which is quick in action and produces a sand of very smooth texture. When used in combination with some type of mill, a very satisfactory sand is obtained with small "new" additions. It is not suitable for oil sand, because of the cleaning difficulty. In the older designs considerable work was required to replace worn or broken pins, but this trouble has been overcome, to some extent, in the latest models.

Floor Sand Mixers.

All the machines considered up to this point have been for the preparation of facing and core sands, although in continuous-casting shops they are sometimes employed for blending floor sand, the sand being mechanically handled from the knocking-out station until it is returned to the moulding box.

This, of course, is not a practicable proposition in an ordinary foundry, and the machine which has revolutionised methods is the throwing aerator. The most widely used is the Pneulec "Royer" (Fig. 2), which has proved capable of standing up to endless work with very infrequent replacements. The sand is fed in by shovel and is caught by a high-speed ribbed belt of special design, carried under spring-loaded blades which break up lumps, and the sand is finally thrown through the air, to fall in a well-mixed stream. A deflector can be fitted to this machine, and this enables the distance that the sand is thrown to be regulated.

The Coleman type passes the sand through a screen, from whence it falls into a chamber in which two arms rotate at a very high speed. These arms catch the sand as it drops, and discharge it with great force. This powerful machine is perhaps seen to best advantage when filling overhead hoppers (as shown in Fig. 3). Both of these machines are easily portable, being mounted on wheels, and they can be moved at will to the most convenient spot. They may be used for facing sand, but are not designed for this purpose, and are therefore not as efficient as some of the devices mentioned earlier.

A type of machine which is very popular in America, but is seldom, or never, seen in this country, is the sand-turning machine. Resembling a reaping machine, it is equipped with large rotating blades, and is driven by power up and down the sand pile on the foundry floor. It appears to be very effective, but the room required to operate it has probably been the reason for its unpopularity in this country.

Sand Handling.

New Sand.

Most foundries receive their raw materials by rail and often a siding is provided inside the building. The discharging of sand is usually done by means of a grab bucket, and, while this is certainly an improvement on shovelling, the time absorbed is considerable. Some very large plants are equipped with tipping machines, but this is too ambitious a method for the ordinary foundry. Personal opinion is that it would be quite practicable to employ a device similar to that used for coaling ships. This is depicted in Fig. 4, and is merely a cradle in which the wagon of sand would be lifted, and emptied directly into the storage bin. This, of course, could only be done with a powerful crane; the wagons usually weigh about 6 tons and carry a 10-ton load of sand; thus a 20-ton crane would be required. The tipping would be done with a 5-ton auxiliary block fitted to the crane. It might be said in justification of this installation that it could be used also for discharging stove coke, furnace coke and possibly pig-iron.

An alternative, if the railway should be at a higher level than the foundry would be to have a rail track above the bins and to arrange for delivery in drop-bottom wagons. In both of these methods it becomes necessary to have some means of moving the wagons and the use of an electric-haulage winch would be an advantage.

Sand for Machine Work.

In the foundry proper, it is unusual to see provision made for filling the moulding boxes by mechanical means; in the case of machine moulding at any rate this is surprising, as the time absorbed by this operation greatly exceeds the time of ramming plus pattern-drawing. The provision of overhead hoppers, feeding by gravity into the moulding boxes, greatly increases the output of machines and operators. In the mass-production shops it is usual to fill storage hoppers by conveyors and elevators of some description, but this practice is not advocated in the type of foundry under consideration, as the initial cost and subsequent upkeep is very heavy. Further, a certain amount of flexibility is necessary and this is not a feature of an automatic system.

There are two methods by which this operation would be best accomplished, the first being by the use of a Coleman throwing machine (Fig. 3). On account of its portability, this can be taken from one moulding machine to another and, when not used for this purpose, it can be employed elsewhere in the foundry. Alternatively the hoppers could be charged with self-tipping boxes (Fig. 5), which would be filled at floor level with a Royer, and then picked up by crane. This system takes full advantage of cranes which are a necessary installation. The boxes should be large in order to keep the hoppers well filled. To prevent the sand jamming in the hopper it is broken up as it is emptied in by two series of bars; the box being rested on the top ones while tipping (Fig. 6). For smaller machines (squeezer) the usual type of feeding gate and chute is very suitable, but in the case of large turn-over moulding machines an arrangement as shown in the diagram is suggested.

Sand for Hand Work.

In the heavy jobbing bay the question of handling floor sand is not so easily settled. If the moulding is done by hand, in either boxes or pits, overhead feeding is not to be considered, but there is still room for an improvement in methods. To give a cleaner foundry, and greatly increase production, a portion of the floor should be set aside for a mixing station and large-capacity boxes employed to transport the sand to the mixing points. Either tipping or drop-bottom boxes may be used, and the design shown in Fig. 7 is suggested. This box is self-closing, and sand can be destributed in a long pile along the side of a moulding pit and would be handier than the usual type. At the mixing station, sand can be passed through a Royer or, in the case of very heavy dry-sand work, allowed to soak and then grabbed directly into the crane boxes.

Though sand-slingers are primarily moulding machines, they may be regarded as handling machines also, and the use of these for all suitable moulding is advocated. The tractor model is, it is thought, the most advantageous, and if full use is to be made of the machine it is necessary to provide the means for quickly filling the hopper.

Facing Sand.

The distribution of facing sand does not present any great difficulties, as the quantities required are comparatively small. At the mixer the sand may be stored in hoppers (Fig. 1), and taken to the moulding stations in barrows, or preferably in the type of box shown in Fig. 8. These can be moved by crane or lift truck, and stand on legs to allow the truck to pass beneath. This feature serves the further purpose of eliminating the need to stoop when taking sand from the box. The hinged side allows easy access to the sand without reducing the capacity of the box.

Core Sand.

In the core shop, sand may be transported from the mixer to the production points by wheel-barrow or tipping truck, but if the sand is then heaped on the floor, it is not thought that the arrangement is satisfactory. For machine work, hoppers can be installed on the same principle as in the moulding shop (much smaller, of course), and in the case of bench work, hoppers need not be fitted with gates. All that is required is an opening at bench level through which sand can be drawn as required (as shown in Fig. 9).

The hoppers may be filled by tipping or drop-bottom boxes if a crane is available at this point; if not, a hoist giving access to an overhead gangway would be necessary. This system could be extended to supply sand for the making of large cores by hand, or boxes of the kind mentioned for facing sand may be employed. As it is never advisable to keep large quantities of oil-sand prepared, no storage hoppers need be installed at the mixing plant.

In conclusion, all foundries of the type considered require to be equipped with cranes and an effort has been made to take full advantage of these in the conveying of sand, thus avoiding the necessity for costly automatic conveyors. This makes for elasticity in operation an essential feature of all such foundries.

Large sums of money are often spent on plant which shortly after its installation ceases to be used. This may be due to faulty design or unsuitable choice of plant, but probably it is the result of flagging interest on the part of the operators. It is not thought that any machine or device has been advocated which cannot perform its function in a satisfactory manner and any original suggestions are so simple that the author has every confidence that they would be successful in practice.

DISCUSSION.

The Branch-President (Mr. H. D. Campbell) said that, having heard Mr. Macnab's Paper, he thought it was a most interesting one, and he felt sure that to many others it had been one of much interest. They all could think of many foundries where an employee had the greatest difficulty in getting his ideas tried or new plant installed. Founders would also confirm the author's remarks regarding the flagging interest which is so often found. He considered that the Paper was worthy of the careful thought of them all.

Mr. D. Sharpe said that he wished to congratulate Mr. Ross on the reading of the Paper and also the author on the way he had tackled an important large subject in connection with economic foundry working. The author was evidently a very practically-minded foundryman. It seemed to him that the question of transport was of utmost importance and the key to the success of any scheme for mechanical sand handling. If they could only get over the difficulty of transporting material to and from the machine the matter was a long way towards being solved. The illustrations had evidently been prepared not to give any particular type of machinery but to illustrate the difficulties which they all appreciated. He had seen recently a foundry using about 300 tons of sand daily, every bit of which was screened and aerated by a machine of a type not mentioned in the Paper. Such a machine would, however, be hopeless in a jobbing foundry. If they could cut out the transport they could influence output production very considerably, but if they did cut out transport they had to be careful they did not upset other operations. It had to be emphasised that every foundry had to have special treatment to meet its particular requirements and conditions. He would like the meeting to convey to the author its appreciation of his efforts.

(*Concluded on page* 244.)

Copper Production Problems.

By "Onlooker."

Perhaps one of the most perplexing problems at present confronting the world of copper is the question of how output curtailment is to be tackled at the coming conference among producers. These discussions are said to be imminent, and those taking part will include representatives from all producers who are parties to the present world curtailment measure, which comes to an end at December 31 next unless broken previously for any special reason. Opinions regarding the course which negotiations will take are rather contradictory, for while in some directions it is presumed that the rate of output will again be reduced on pressure from the high-cost producers, another school of thought inclines to the view that those interests which can earn a profit at 6 cents will insist upon increasing their rate of output.

That the scheme for reducing output was a wise innovation cannot be doubted, and one hesitates to think to what point the price would have declined had no such corrective measures been adopted. Even so, with production running at only 20 per cent. of capacity, it is impossible to report much, if any, reduction in the stocks in America, for the apparent fall of a few thousand tons recently seen in the States is due to transfer of the metal to Britain in expectation of the duty shortly to be imposed. It may be taken for granted, therefore, that the effect of the curtailment scheme has been to prevent any increase in the huge stocks which had been accumulated, but that consumption has not improved at all. One fact, however, does emerge with somewhat startling clarity, and that is the difficult position in qualities of copper other than electrolytic, for while both in Europe and the States a large tonnage of this grade is available, the amount of fire-refined and Bessemer is almost negligible.

This situation is one which will require most careful consideration at the producers' conference, for whereas in the past we have been able in this country to draw upon supplies of fine refined copper from the United States, Chile and certain European countries, the position when the duty is imposed will be that consumers requiring this quality—and our requirements in this country are very considerable—must take Rhodesia's product or else go without. Similarly with Bessemer copper, but here Chile is almost our sole supplier, and to that extent the exclusion of her copper will be a most serious blow to users. The curtailment pact has reacted very seriously on the fine refined and Bessemer position, particularly on the latter, for it must be remembered that not every type of Bessemer or blister, as it is sometimes called, is suitable for the rolling mills, and, owing to the drastic cutting down of output, stocks, whether at the plants or in consuming areas, are virtually nil.

Just what the present curtailed rate of Empire copper mines in Africa is cannot be stated with exactitude, but there is no doubt that it must be augmented to a considerable extent if all copper of Bessemer and fine refined quality from our Empire sources is going to be excluded. Probably from 20 per cent. to 50 per cent. increase will be necessary to cover even our present reduced rate of use, and one wonders what will be the effect of such an announcement at the conference, where feeling will in any case be running pretty high owing to the reservation of the British market for certain producers. If Rhodesia is going to increase, then Chile will speed up, too, and without doubt the Belgian Congo will follow suit, since suggestions have already been made to that effect by this producer. What is to be the upshot of it all?

Quite apart from considerations which may arise from the application of a duty, here there can be little doubt that the world's low-cost producers of copper, *e.g.*, Canada, Chile and Africa are growing tired of carrying the burden of high-cost properties on their backs, for that in effect is what the present arrangement means. At the present figure of 6 cents there is little doubt but that the countries named could earn good profits were they producing at full capacity, and since the curtailment pact has done little more than arrest the price decline and has not proved instrumental in raising selling values to any extent, there appears to be little or no object from their point of view in continuing.

At the same time there is not much fun in running at 100 per cent. capacity to sell on a market demoralised by a price war, and since consumption of copper has certainly not improved to any great extent it is obvious that a return to a programme of unrestricted outputs would be dangerous to a degree. Actually the imposition of a duty on imported copper at the present time is going to be as disastrous for the producers as it is for British consumers, and in the best interests of the trade it is to be hoped that its application will be deferred until the situation has become clearer.

Heat-Treatment of Carbon Steels in the Light of X-Ray Investigations.

A survey of what takes place on quenching and tempering high-carbon steels, based particularly on the results of X-ray examination, was given by G. Kurdjumow, of Leningrad, in a recent issue of "Archiv für das Eisenhüttenwesen." Very rapidly-quenched steel consists of surface-centred austenite and tetragonal space-centred martensite. The regular alteration of the parameter of the two types of crystals with the carbon content shows that both are solid solutions.

If the speed of cooling is sufficient to cool the austenite down to the Ar″-point, the crystal structure of the quenched steel depends only on the cooling in the range from Ar″ to room temperature. The result is either a tetragonal lattice or a decomposition product (the "cubic martensite") or non-homogeneous intermediate structure. With slow rates of cooling leading to the transformation of the austenite at Ar′, the quenched steel contains crystals of α-iron and of cementite. In this case the transformation proceeds from crystallisation nuclei of ferrite and cementite, and the size of the resultant crystals is determined by the rate of cooling. With very rapid cooling the austenite lattice changes suddenly into the tetragonal. The transformation proceeds so rapidly that diffusion is not possible; the carbon therefore remains in solution. According to the orientation of the austenite grain to the martensite crystals formed from it, the transformation can be represented by two simple displacements. Already during the cooling-down the separation of the carbon from the tetragonal lattice sets in. How far this decomposition of the tetragonal lattice will proceed depends on the Ar″ temperature and on the progress of the cooling in the range from Ar″ to room temperature. With very slow cooling within this temperature range a cubic space-centred lattice is produced, which only differs from that of α-iron by lack of sharpness in the lines of the X-ray photogram, probably mainly due to distortions of the lattice. There are no data available relating to X-ray investigations in regard to the condition of the carbon in this product of the decomposition of martensite.

Another stage in the Mersey Docks and Harbour Board's £250,000 scheme for the modernisation of dock bridges at Birkenhead and Liverpool was reached last week, when the second of four rolling-bascule bridges on the Birkenhead side was opened to traffic.

Institute Elects New Members.

At a meeting of the General Council of the Institute of British Foundrymen, held at the Queen's Hotel, Birmingham, on October 15, 1932, the following were elected to the various grades of membership.

As a Subscribing Firm.

Adams Hydraulic, Limited, York, sewage disposal engineers.

As Members.

R. W. Allott, managing director, Nitricast-iron Company, King Street, Sheffield; G. L. Bailey, M.Sc., metallurgist, British Non-Ferrous Metals Research Association; F. G. Bird, assistant sales representative, Armstrong, Whitworth & Company, Gateshead; G. A. Clavey, foundry manager, J. Stone & Company, Deptford; W. Cope, representative (practical foundryman), W. Aske & Company, Halifax; T. C. Gilchrist, works metallurgist, L.M.S. Railway Company, St. Rollox Works; T. Jianee, ironfounder, Jianee & Company, 24-28, Grove Road, Singapore; E. Potts, foundry manager, Westinghouse Brake & S.S. Company, Limited; S. Protheroe, master patternmaker, S. Protheroe, Cardiff; J. Stafford, metallurgical chemist, 12, Nelson Square, Bolton; S. H. Wright, foundry manager, Francis & Graham (Pty., Limited), Congella, Durban; J. G. Wrightson, ironmaster, Head, Wrightson & Company, Thornaby-on-Tees; Comm. L. G. Pennington, R.N., in charge of foundry, H.M. Dockyard, Chatham.

As Associate Members.

E. T. Austin, metallurgical chemist, B.C.I.R.A., Birmingham; P. St. L. Attenborough, metallurgical chemist, Asquith's, Limited, Modern Foundries, Halifax; N. H. Clapp, foreman brass moulder, Beyer, Peacock & Company, Gorton; H. H. Cornwell, assistant manager, Cornwell & Company, Openshaw; A. Drowe, iron moulder, Sterling Manufacturing Company, Cubitt Town; S. Hale, iron moulder, Hattersleys, Limited, Ormskirk; B. Haigh, laboratory assistant, Ford Motor Company, Dagenham; E. Hunter, foundry technologist; S. Hyde, foundry foreman, Triplex Foundry, Limited, Great Bridge; J. L. King, metallurgist's works assistant, L.M.S. Railway Company, Crewe; D. Kirk, engineering apprentice, Adams Hydraulic, Limited, York; J. E. O. Little, foundry chemist, L.N.E. Railway Company, Doncaster; H. Lowe, foreman iron moulder, L.M.S. Railway Company, St. Rollox Works; C. E. Lumb, assistant metallurgist, J. Howden & Company, Glasgow; C. E. Morrish, foundry chemist, Bullers, Limited, Tipton; E. Peters, chargehand patternmaker, Vaughan Crane Company, Openshaw; P. Thronton, metallurgist, National Steel Foundry, Leven; R. S. Turner, moulder, H. Pontifex & Sons, Tyseley; D. H. Williams, roll caster and foundry chemist, Guest & Sons, West Bromwich; K. G. Williams, foundry traveller in iron castings, Black Lake Ironworks; J. W. Hallsworth, foundry foreman, T. Firth & J. Brown, Limited; H. Hinchliffe, moulder, English Steel Corporation, Limited.

As Associates.

J. T. Clark, foundry apprentice, Hattersley (Ormskirk), Limited; A. Hubball, patternmaker; F. L. Topham, iron moulder, Hick, Hargreaves & Company, Limited, Bolton.

A further meeting of the International Zinc Cartel is to be held in Paris to-day. The agenda of the meeting has not yet been definitely fixed, but it is not expected that any increase in the total output of the Cartel, which provisionally has been fixed at 45 per cent., will be decided upon. The agreement has in the meantime been prolonged till the end of December and no notice has so far been received to dissolve the Cartel.

This Week's News in Brief.

Trade Talk.

Messrs. Henry Robb, Limited, shipbuilders, Leith, have received an order for a powerful sea-going twin-screw tug for service at Cochin, India.

Messrs. R. W. Collin & Company, ironfounders, Sunderland, have transferred their business to larger premises at Pallion Foundry, St. Luke's Road, Sunderland.

The cargo vessel "Baron Douglas," built by Messrs. Lithgows, Limited, Port Glasgow, for Messrs. H. Hogarth & Sons, Limited, Glasgow, has completed successful trials on the Firth of Clyde.

The foundry workers of Bonnybridge and district, who have been on short-time working only three or four days per week for some time past, started on October 10 working on a four- to five-day week.

Encouraged by the large demand for Shotts bricks, Shotts Iron Company, Limited, have opened a new brickwork at Shotts, which will provide employment for a considerable number of additional workers

The Institution of Welding Engineers has decided again to offer the gold medal of the Institution and a prize of £10 10s. for the best Paper this year by a working welder on "Improvements in Welding Practice."

The train-ferry steamer "Changkiang," built at a cost of £70,000 for the Chinese Government, was launched from the Walker-on-Tyne yard of Messrs. Swan, Hunter & Wigham Richardson, Limited, last week.

Sir Frank E. Smith, secretary of the Department of Scientific and Industrial Research, formally opened, on October 6, the recently-completed buildings of Robert Gordon's Technical College, Aberdeen, which cost £125,000.

The contract for the steel work in connection with the new power station for the Galloway Power Company has been secured by Messrs. Redpath, Brown & Company, Limited. The value of the contract is in the neighbourhood of £16,000.

Qualcast, Limited, of Derby, have issued for public subscription 75,000 7 per cent. cumulative preference shares of £1 each at par, part of the authorised share capital of £200,000, of which £125,000 in 5s. ordinary shares was already issued.

Swansea Borough Council has approved the recommendation of the Electricity Committee that the tender of International Combustion, Limited, for the steam-raising plant for the Tir John North super-electric power station be accepted, the price being £238,450.

Messrs. Henry Robb, Limited, Leith, have just booked an order for a powerful sea-going twin-screw tug for service at Cochin, India. The vessel will be fitted with two sets of triple-expansion engines developing 1,000 i.h.p. and two oil-burning boilers. She will also be equipped with fire-fighting and salvage machinery and wireless installation.

The Burntisland Shipbuilding Company, Limited, Burntisland, have received an order to build a 3,300 ton deadweight collier for London owners. This makes the seventh contract booked by the Burntisland yard during the current year and brings the work in hand to four vessels. The vessel, like the one recently ordered for London owners, will be of a special design.

The Caledon Shipbuilding & Engineering Company, Limited, Dundee, have secured an order to build a 3,500-ton steamer for the Colonial Sugar Refining Company, Limited, of Sydney, New South Wales. The vessel, which is to be of special design to suit the Refining Company's Australasian sugar trade, will be fitted with propelling machinery by the North Eastern Marine Engineering Company, Limited, Wallsend-on-Tyne.

Beecroft & Partners, Limited, Retort Works, Mappin Street, Sheffield, have been appointed stockists for accessories and specialities in connection with the nitration process handled by Messrs. Nitralloy, Limited, of Norris Deakin Buildings, King Street, Sheffield. In this connection they have evolved and are manufacturing a protective paint for the nitration process, which is being marketed under the name of "Crulin Protective Paint."

The thirteenth session of Carron Company's works recreation club was entered upon on October 11, when Mr. H. H. Metcalfe presided over a very large attendance of members and friends. The chairman, in his introductory address, expressed his pleasure at being able to intimate that, despite the dull times through which they were passing and the local counter-attractions, all the organisations connected with the club were flourishing. The opening attraction was a concert by the premier Scottish concert band, the Bonnybridge and District Band, under the direction of Lieut. Gregor J. Grant.

Obituary.

Mr. A. M'Gown, founder of the Ulster Galvanising Works, Mountpottinger Road, Belfast, died recently.

Mr. Thomas Young, a director of the Shields Engineering & Dry Dock Company, Limited, North Shields, has died, aged 78.

Mr. Gilbert Keighley, managing director of Messrs. George Keighley, Limited, Bankhouse Ironworks, Burnley, died recently, aged 76.

Mr. William Roger Dawe, a former manager of the Chantrey Steel & Crank Works, Attercliffe, died on Saturday, October 8, at Sheffield. Mr. Dawe, who was in his 84th year, went to Sheffield in 1884 to join Messrs. Woodhouse & Rixson, at Chantrey Steelworks, where he was works manager until his retirement in 1919.

Mr. James Gow Dickson, a well-known native of Denny, died at his home in Denny on October 12. Mr. Dickson, who was in his 83rd year, spent some of his early days abroad before becoming engineer to Messrs. Cruickshank & Company, Limited, Denny Iron Works, where he was employed for over 50 years before retiring two years ago. He was something of a character—a type of canny Scot, complete even to the snuffbox—which is fast becoming extinct.

Mr. F. Mackman Watson, chairman and managing director of Messrs. Guest & Chrimes, Limited, engineers, of Rotherham, died early last week. A native of Aldridge, Staffordshire, Mr. Watson joined the engineering staff of Messrs. Guest & Chrimes as a young man, and was appointed assistant manager in 1898. He succeeded to the business in 1914, on the death of his uncle, Mr. C. E. Chrimes, in 1917, the firm becoming a private limited company.

The death occurred very suddenly, at his residence in Falkirk, on October 13, of Mr. Walter W. Bauchop, who had for over forty years been in the employ of the Grahamston Iron Company, Limited, Falkirk. Mr. Bauchop, who was 65 years of age, had not been in the best of health for some months, but was able to continue at business until two days before his death. He was a noted rifle shot, and for many years was a regular and successful competitor at Bisley, participating in the King's Hundred on several occasions, and represented Scotland in the Bisley international shoot.

The death occurred at his home in Manse Road, Wishaw, on October 14, of Mr. John F. Williams, of the Excelsior Iron & Steel Works, Wishaw. Mr. Williams, who was a native of Staffordshire, was 76 years of age, and was one of the partners and latterly chairman of John Williams & Company (Wishaw), 1922, Limited. The Excelsior Iron & Steel Works was founded by his father in 1866. Mr. Williams was a J.P. for the County of Lanark, and well known in iron and steel circles in the West of Scotland. He retired from active work about a year ago on account of failing health.

Personal.

Mr. John Ramage has been appointed secretary to the Industrial Co-partnership Association.

Lord Leverhulme is to be the principal guest at the annual dinner of the London Iron and Steel Exchange, to be held at the Dorchester Hotel, Park Lane, on January 24.

Mr. Charles M. Schwab has arrived from New York. He is to receive the Melchett medal for distinguished achievement in industry at the annual meeting of the Institute of Fuel.

Mr. James Clifton Colquhoun has been elected chairman of the Manganese Bronze & Brass Company, Limited, in succession to the late Colonel O. C. Armstrong. Mr. E. Andrew Mearns and Mr. Bernard P. R. Parsons have been appointed managing directors, in place of the late Mr. James C. Gray.

Mr. Charles E. Hickman, grandson of the late Sir Alfred Hickman, who was the first President of the Wolverhampton and District Engineering Society, was last week elected President of that body for the ensuing year. Mr. Hickman is connected with the Staffordshire Steel & Ingot Works, Bilston.

Mr. S. T. Johnson, who in 1919 was President of the Foundrymen's International Technical Committee and the American Foundrymen's Association, has retired from active participation in the Obermeyer Company, of which he was Vice-President. He will, however, still continue as President of the Standard Sand & Machine Company, of 547, W. Washington Boulevard, Chicago. Mr. Johnson is a native of Scotland, and headed the American delegation to Europe in 1929 for participation in the London International Foundry Congress.

Under the Order in Council dated February 6 the Lord President of the Council has appointed Prof. Alfred Fowler, D.Sc., F.R.S., and Sir Clement D. M. Hindley, K.C.I.E., M.Inst.C.E., M.Inst.T., M.I.E. (Ind.), to be members of the Advisory Council to the Committee of the Privy Council for Scientific and Industrial Research, in place of Sir J. Alfred Ewing, K.C.B., J.P., LL.D., D.Sc., Sc.D., F.R.S., M.Inst.C.E., and Sir David Milne-Watson, LL.D., D.L., who have retired on completion of their terms of office. The Lord President of the Council has also appointed Brigadier-General Sir Harold B. Hartley, C.B.E., M.C., F.R.S., President of the British Cast Iron Research Association, to be chairman of the Fuel Research Board, and Mr. N. V. Sidgwick, O.B.E., Sc.D., F.R.S., to be chairman of the Chemistry Research Board of the Department of Scientific and Industrial Research, in place of the late Sir Richard Threlfall, G.B.E., F.R.S.

Wills.

Beresford-Jones, Harry, of Upton, Chester, a director of the Wolverhampton Corrugated Iron Company, Limited, and other companies ...	£91,829

Chaplets.

(*Concluded from page* 236.)

ing the incomplete fusion of wrought-iron chaplets is that of surface cleanliness. It may frequently occur that in the stores consignments tend to display unevenness of surface from causes which are not difficult to name. Of these rusting is probably the most frequent of all, while unevenness of tinning also may give rise to similar effects. Many instances of the importance of general cleanliness can be recalled in this connection and investigations into the causes lead to the conclusion that more attention needs frequently to be paid to the operation of tinning. Most tin deposits are indeed at best somewhat porous and by no means really impervious to moisture. Consequently it is important to ensure that not only is the surface clean before tinning operations are begun but that sufficient thickness of deposit, and moreover, uniform thickness of deposit be secured in order to acquire adequate protection against moisture. The thickness of deposit will naturally vary with the conditions of use, but examinations of chaplets made by the author have not infrequently pointed to imperfect tinning as responsible for at least some casting troubles. Experience shows also that upon removal of the tinned surface during laboratory tests the undersurface sometimes exhibits a very unclean condition and one is lead to infer, although the evidence does not prove it conclusively, that rusting before tinning has been allowed to take place. Attention to all these small matters of detail would undoubtedly prove beneficial in helping to limit the losses or rejections.

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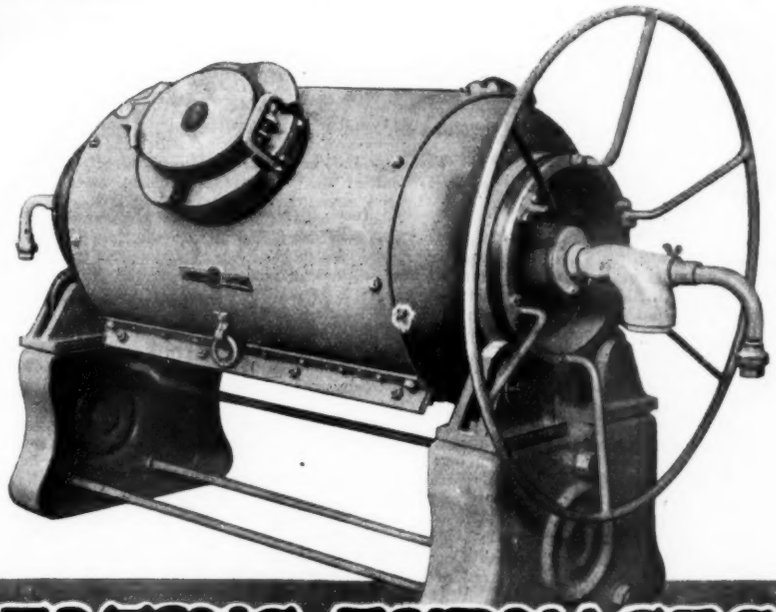

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Raw Material Markets.

Sellers of iron and steel are expressing disappointment at the slowness of business, their anticipations of an autumn revival having so far shown little sign of realisation. There are indications, however, that the wheels of trade are slowly beginning to turn again, and it is generally recognised that the process of recovery must inevitably be a slow one. The Canadian tariff concessions should considerably favour the British iron and steel industry, and the announcement of the details considerably heartened the markets. The existing duties on iron and steel imports into this country also come up for revision towards the end of this month, and it is thought that a stronger and more permanent barrier will be erected against Continental material.

Pig-Iron.

MIDDLESBROUGH.—Business in this area has again relapsed. Transactions are only for the smallest quantities, and, indeed, some of the Cleveland foundries are using Midlands iron, being aggrieved by the fact that they are called upon to pay the fixed official price of 58s. 6d. per ton for No. 3 G.M.B., while the ascertained average price for the third quarter of the year was 51s. 10½d.—indicating that consumers in Scotland and elsewhere are getting considerably more favourable terms. There is little probability of the ironmasters making any reduction, however, while trade remains at its present level. The official prices are nominally unchanged, No. 1 Cleveland foundry iron being at 61s. per ton, No. 3 Cleveland G.M.B. 58s. 6d., No. 4 foundry 57s. 6d. and No. 4 forge 57s. per ton.

The slackness of the demand for East Coast hematite is being aggravated by the increased production now being put upon the market. Prices have been again reduced, but surplus stocks continue to grow at a disturbing rate. Mixed numbers have now been frankly reduced to 59s. per ton—a figure which is already admittedly "nominal." On the West Coast the position is more satisfactory. Local consumption has been maintained, so that stocks have been reduced, and a second furnace has been relighted at Millom. The quotation for Bessemer mixed numbers remains nominally 66s. at works.

LANCASHIRE.—New business is scarce and is generally limited to deliveries over a period of about a month, the foundries complaining that their position does not warrant further commitments. The demand from both the heavy engineering and jobbing foundries is at a low level, while the proportion of scrap consumed remains unduly high. For delivery to users in the Manchester price zone, Staffordshire, Derbyshire and North-East Coast makes are still on offer on the basis of 67s. per ton, with Northamptonshire at 65s. 6d., Derbyshire forge at 62s., and West Coast hematite at around 81s. Scottish makers are still asking about 84s. 6d. per ton for delivery equal to Manchester, although there is evidence of "shading" by merchants. With regard to Indian iron shipments are still coming through to Manchester and Liverpool, with quotations for delivery in the district ranging from about 67s. to 75s. per ton.

MIDLANDS.—The occasion of the ironmasters' quarterly meeting at the Birmingham Exchange last Thursday was marked by a good attendance, but the business arranged was small, owing to the limited activity in the consuming industries. The furnaces are putting iron into stock, their output continuing to exceed the demand. Prices of Midland brands, which are controlled, are unchanged at 62s. 6d. for Northants No. 3 and 66s. for North Staffordshire, Derbyshire and Lincolnshire No. 3, delivered Birmingham and Black Country stations. A little Cleveland No. 3 foundry iron comes into this district at 66s., delivered, and there is also a moderate tonnage of Scottish and other medium-phosphorus iron used for special work. The present price of Scottish No. 3 ranges from 83s. 6d. to 87s. 6d. delivered.

SCOTLAND.—The industrial outlook for the winter is far from bright, shipbuilding being at the lowest ebb ever recorded. Short time continues at those foundries that are still working, and the general demand for pig-iron is limited. A blast furnace has been restarted on basic iron, making a total of two in blast in Scotland (the other producing foundry iron). It is understood that the additional output is mostly required by the producers themselves. There is no alteration in prices. No. 3 Scottish foundry iron is at 67s. 6d. at furnaces, with a minimum of 2s. 6d. extra for No. 1. Middlesbrough No. 3 is quoted at the special price for Scotland of 55s. 6d. at Falkirk, with other English irons at about 1s. 6d. less. The Indian foundry iron coming in here consists of low-phosphorus grades and does not compete with these English irons.

Coke.

Conditions in the foundry-coke market show no improvement. There is little forward buying, although consumers could ensure supplies to the end of the year at the present rates, which have been unchanged for some time now. Best Durham foundry coke at Birmingham is quoted at 36s. 9d. to 38s., with inferior grades at 2s. 6d. or so less, while Welsh coke varies from 30s. to 45s. per ton, according to analysis, delivered Birmingham and district.

Steel.

Business in the steel markets is quiet, as the tendency both at home and abroad is to wait until the effects of the Ottawa agreements can be judged. This is a natural consequence which will probably last for a week or so; but there has been a considerable volume of inquiry, which shows that buyers are keeping in touch with market conditions, and this, it is believed, will develop into actual business when affairs become more settled. In the semi-finished steel market, consumers appear to be largely living on stocks in hand and are placing only small orders with producers. Practically all the business placed is now going to the British makers, and dealings in Continental material are negligible. Business in finished steel is light, but inquiries from overseas, particularly from Empire markets, have increased. There are indications that orders are being held up until the changes effected by the Ottawa agreement can be gauged.

Scrap.

The consumption of scrap iron remains limited, owing to the slowness of conditions at the foundries, while the supplies upon the market are as heavy as ever. Conditions are particularly severe in Scotland, where the price of ordinary cast iron has dropped to 48s. 6d. per ton (heavy steel material also falling to 32s. 6d.). Quotations for heavy cast iron in South Wales have levelled down to 39s. In the Midlands, light cast iron is slightly stronger at 35s. 6d. per ton. General quotations otherwise remain unchanged, merchants stating that there is insufficient business at stake to justify further price-cutting, sales already being made at uneconomic levels.

Metals.

Copper.—At the moment the trade demand for this metal is still at a low level, but inquiries are coming in from consumers, indicating an increasing desire to secure forward supplies at the present low levels, before the market is supported by the imposition of new import duties. Many are content to hang back for a week or two, however, in the knowledge that the supplies on the market are too heavy to allow any immediate rise in values. At the moment the official quotation for electro is unchanged, but it is being widely undercut.

Closing quotations :—

Cash.—Thursday, £32 2s. 6d. to £32 3s. 9d.; Friday, £31 10s. to £31 11s. 3d.; Monday, £31 16s. 3d. to £31 17s. 6d.; Tuesday, £31 12s. 6d. to £31 15s.; Wednesday, £32 6s. 3d. to £32 8s. 9d.

Three Months. — Thursday, £32 6s. 3d. to £32 7s. 6d.; Friday, £31 12s. 6d. to £31 13s. 9d.; Monday, £32 to £32 1s. 3d.; Tuesday, £31 16s. 3d. to £31 17s. 6d.; Wednesday, £32 10s. to £32 11s. 3d.

Tin.—The industrial demand for tin remains very subdued throughout Europe, in spite of the relapse in value. The South Wales tinplate industry maintains a steady consumption, but otherwise the demand for tin is irregular. The market has risen so rapidly from the low levels of a few months ago that consumers are hesitant about making forward purchases of any importance—hence the slight relapse and slow conditions of the past fortnight.

Official closing prices :—

Cash.—Thursday, £151 7s. 6d. to £151 10s.; Friday, £149 15s. to £150; Monday, £151 10s. to £151 12s. 6d.; Tuesday, £153 to £153 2s. 6d.; Wednesday, £153 2s. 6d. to £153 5s.

Three Months.—Thursday, £152 12s. 6d. to £152 15s.; Friday, £150 17s. 6d. to £151; Monday, £152 2s. 6d. to £152 5s.; Tuesday, £153 7s. 6d. to £151 10s.; Wednesday, £153 7s. 6d. to £153 10s.

Spelter.—The continued reduction, month by month, of the producers' stocks, aided by the strict curtailment of output, is a favourable factor, but, even so, the market is little more than steady. This is due to the continued reticence of industrial buyers, who are themselves hampered by the slow demand for their own products. There are indications, however, that industry is beginning to stir again, and should the movement gain impetus, this market should be one of the first to derive advantage.

Daily fluctuations :—

Ordinary. — Thursday, £14 15s.; Friday, £14 7s. 6d.; Monday, £14 10s.; Tuesday, £14 10s.; Wednesday, £14 18s. 9d.

Lead.—The demand for lead in this country, particularly from the cable-makers, is tending to decrease; this may be partially credited to the large stocks held at many of the works. On the Continent, however, similarly poor conditions prevail, and consequently prices are inclined to sag.

The week's prices have been :—

Soft Foreign (Prompt).—Thursday, £11 18s. 9d.; Friday, £11 13s. 9d.; Monday, £11 15s.; Tuesday, £11 11s. 3d.; Wednesday, £11 18s. 9d.

The Mechanical Preparation and Handling of Sand in Non-Repetition Foundries.

(*Concluded from page* 240.)

Mr. Graham said that he had had a good deal of experience and several shops he had been in it was found that the men working on the floor very often went down to the sand-mixing department and wheeled up his sand simply because he could not get the crane when required. That state of affairs was often due to the crane not being fit to cope with all the work it had to do, and the men got tired of waiting and went back to the shovel and barrow.

Mr. N. McManus, M.B.E., said the question of mechanical machines and tools required very careful analysing and consideration before they were installed. They were often to blame for not giving such consideration or having seen one machine doing excellent work under a particular set of conditions and then take that machine as the one for their work under quite different conditions. Very carefully analysing of conditions and fitting the machine to the conditions and not the conditions to the machine, the latter was very often the reason why machines were left idle.

The Chairman said that he was sure that they all desired to accord a vote of thanks to Mr. Macnab for his very interesting Paper, and to convey to him their appreciation of the manner in which he had dealt with a difficult subject in a concise manner. The discussion had not been long but several ideas worth thinking about had emerged, and which he thought many could apply to their own foundries. He asked them also to thank Mr. Ross for his reading of the Paper and his final exposition.

At the conclusion of the meeting the members and their lady friends adjourned to the Cadora Restaurant for tea, after which they spent an enjoyable evening at cards and music. Prizes were won at cards by Miss M. Hurst, Miss N. Longden and Mrs. Young, Messrs. J. P. Young, John Bell and Robert Waddell. Misses Hurst and Mr. A. Mearns sang at intervals during the evening, and Mr. H. Hurst, Vice-President, presided at the piano.

A contract for the supply and delivery of cast-iron pipes and specials for a trunk water main from Aston to Wickerlsey has been placed with the Staveley Coal & Iron Company, Limited, by the Rotherham Rural District Council, the amount of the contract being £6,639.

Average tensile strength is 73,000 lbs./sq. inch

SAND CASTINGS

"Many excellent castings are produced in green sand moulds, more particularly when the moulds are very thoroughly skin dried before pouring. For the finest work, it is always safest to use dry sand to avoid the possibility of much careful melting and handling being negatived by moisture in the mould.

For this same reason, to ensure metal lying quiet and undisturbed during solidification, it is essential to pay close attention to the venting of cores and otherwise confined bodies of sand, so that expanding air is quite free to leave via the vents instead of bubbling through or causing fluttering of the metal during solidification.

It is recommended that when runners are standardised for any particular job, the runner blocks may with advantage be bonded with sodium silicate and water (water glass), which will neither burn out nor give off gases during pouring." (The foregoing is an extract from our Booklet No. 315 "Aluminium Bronze," which will be sent gratis to all interested.)

ALUMINIUM BRONZE

THE BRITISH ALUMINIUM CO. LTD.

ALUMINIUM PRODUCERS, ADELAIDE HOUSE, KING WILLIAM ST., LONDON, E.C.4.

Telephone:—MANSION HOUSE 5561 & 8074 (5 Lines) Telegrams:—"CRYOLITE, BILGATE, LONDON."

F.T.J. 20-10-32.

CAST IRON FLANGED PIPES

2 in.—12 in. & CONNECTIONS. to 24 in. dia.

WE HAVE FIFTY-TWO YEARS OF ACCUMULATED EXPERIENCE AND METAL PATTERNS.

JAMES & RONALD RITCHIE, LTD.,

Telephone: 3852 (2 Lines). MIDDLESBROUGH. Telegrams: "Ritchie, Middlesbrough."

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	32	6	3
Three months	32	10	0
Electrolytic	36	10	0
Tough	33	10	0
Best selected	34	0	0
Sheets	65	0	0
India	44	15	0
Wire bars	36	15	0
Do., Nov.	36	15	0
Do., Dec.	36	15	0
Ingot bars	36	15	0
H.C. wire rods	39	10	0
Off. av. cash, September	35	0	7 3/4
Do., 3 mths., September	35	1	1 7/11
Do., Sttlmnt., September	35	0	6 9/11
Do., Electro, September	38	13	2 2/11
Do., B.S., September	37	4	2
Do., wire bars, September	39	0	0
Solid drawn tubes			10d.
Brazed tubes			10½d.
Wire			7d.

BRASS.

Solid drawn tubes	9d.
Brazed tubes	11d.
Rods, drawn	8½d.
Rods, extd. or rlld.	5d.
Sheets to 10 w.g.	7¾d.
Wire	7½d.
Rolled metal	7¼d.
Yellow metal rods	4½d.
Do. 4 × 4 Squares	5½d.
Do. 4 × 3 Sheets	5½d.

TIN.

	£	s.	d.
Standard cash	153	2	6
Three months	153	7	6
English	154	15	0
Bars	156	15	0
Straits	158	15	0
Australian	157	0	0
Eastern	157	7	6
Banca	160	0	0
Off. av. cash, September	152	16	3
Do., 3 mths., September	154	7	7 1/11
Do., Sttlmt., September	152	16	1 7/11

SPELTER.

	£	s.	d.
Ordinary	14	18	9
Remelted	15	5	0
Hard	13	0	0
Electro 99.9	17	5	0
English	15	15	0
India	14	2	6
Zinc dust	22	0	0
Zinc ashes	2	5	0
Off. aver., September	15	10	8 3/4
Aver. spot, September	15	9	1 1/11

LEAD.

	£	s.	d.
Soft foreign ppt.	11	18	9
Empire	12	1	3
English	13	15	0
Off. average, September	13	4	8 3/4
Average spot, September	13	2	5 7/11

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	24	10	0
Do., V.M. ex-whse.	22	10	0
Rods	27	0	0
Boiler plates	23	0	0
Battery plates		—	

ANTIMONY.

	£	s.	d.
English	35	0	0 to 42 10 0
Chinese	23	15	0
Crude	16	0	0

QUICKSILVER.

	£	s.	d.
Quicksilver	9	10	0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
25%	£8 0 0
45/50%	£13 15 0
75%	£19 10 0
Ferro-vanadium—	
35/50%	12/8 lb. Va.
Ferro-molybdenum—	
70/75% c. free of Mo.	6/3 per lb.
Ferro-titanium—	
23/25% carbon-free	10d. lb.
Ferro-phosphorus, 20/25%	£20 0 0
Ferro-tungsten—	
80/85%	1/7½ lb.
Tungsten metal powder—	
98/99%	1/10½ lb.
Ferro-chrome—	
2/4% car.	£34 5 0
4/6% car.	£25 15 0
6/8% car.	£24 10 0
8/10% car.	£22 5 0
Ferro-chrome—	
Max. 2% car.	£36 10 0
Max. 1% car.	£42 12 6
Max. 0·70% car.	£43 17 6
70%, carbon-free	1/- lb.
Nickel—80/99.5%	£240 to £245
"F" nickel shot	£216 0 0
Ferro-cobalt	7/9 lb.
Aluminium 98/99%	£100 0 0
Metallic chromium—	
96/98%	2/9 lb.
Ferro-manganese (net)—	
76/80% loose	£10 15 0 to £11 5 0
76/80% packed	£11 15 0 to £12 5 0
76/80% export	(nom.) £9 15 0
Metallic manganese—	
94/96% carbon-free	1/4 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	2s. 0d.
Finished bars, 18% tungsten	2s. 9d.

Per lb. net, d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to 1/16 in.	1/- lb.
Flats, ½ in. × ⅛ in. to under 1 in. × ⅛ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP.

	£	s.	d.	£	s.	d.
South Wales—						
Heavy steel				1	18	0
Bundled steel and shrngs.	1	15	0 to	1	17	0
Mixed iron and steel				1	15	0
Heavy cast iron				1	19	0
Good machinery				2	5	0
Cleveland—						
Heavy steel	1	12	6 to	1	15	0
Steel turnings				1	7	6
Cast-iron borings				1	2	6
Heavy forge				2	10	0
W.I. piling scrap				2	2	6
Cast-iron scrap	1	15	0 to	1	16	0
Midlands—						
Light cast-iron scrap				1	15	6
Heavy wrought iron				2	2	6
Steel turnings, f.o.r.				0	19	0
Scotland—						
Heavy steel				1	12	6
Ordinary cast iron				1	18	6
Engineers' turnings				1	7	6
Cast-iron borings				1	10	0
Wrought-iron piling				1	19	0
Heavy machinery				2	4	6

London—Merchants' buying prices delivered yard.

	£	s.	d.
Copper (clean)	26	0	0
Brass	19	0	0
Lead (less usual draft)	11	0	0
Tea lead	9	10	0
Zinc	8	10	0
New aluminium cuttings	72	0	0
Braziery copper	23	0	0
Gunmetal	22	0	0
Hollow pewter	82	0	0
Shaped black pewter	65	0	0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	61/-
Foundry No. 3	58/6
Foundry No. 4	57/6
Forge No. 4	57/-
Hematite No. 1	59/6
Hematite M/Nos.	59/-
N.W. Coast—	
Hem. M/Nos. d/d Glas.	70/-
d/d Birm.	84/6
Malleable iron d/d Birm.	117/6
Midlands—	
Staffs No. 4 forge*	61/-
No. 3 fdry.*	66/-
Shrops basic	—
Cold blast, ord.	—
roll iron	—
Northants forge*	57/6
fdry. No. 3*	62/6
fdry. No. 1*	65/6
Derbyshire forge*	61/-
fdry. No. 3*	66/-
fdry. No. 1*	69/-
basic*	—

*d/d Black Country dist.

Scotland—	
Foundry No. 1	70/-
No. 3	67/6
Hem. M/Nos. d/d	67/6
Sheffield (d/d district)—	
Derby forge	58/6
fdry. No. 3	63/6
Lincs forge	—
fdry. No. 3	63/6
E.C. hematite	73/6
W.C. hematite	83/6
Lancashire (d/d eq. Man.)—	
Derby forge	62/-
fdry. No. 3	67/-
Staffs fdry. No. 3	67/-
Northants fdry. No. 3	65/6
Cleveland fdry. No. 3	67/-
Dalzell, No. 3 (special)	102/6 to 105/-
Glengarnock, No. 3	84/6
Clyde, No. 3	84/6
Monkland, No. 3	84/6
Summerlee, No. 3	84/6
Eglinton, No. 3	84/6
Gartsherrie, No. 3	84/6
Shotts, No. 3	84/6

FINISHED IRON AND STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.	£	s.	d.
Bars (cr.)	9	5	0 to	9	15	0
Nut and bolt iron	7	15	0 to	8	10	0
Hoops	10	10	0 to	12	0	0
Marked bars (Staffs) f.o.t.				12	0	0
Gas strip	10	10	0 to	12	0	0
Bolts and nuts, ¾ in. × 4 in.				12	0	0
Steel—						
Plates, ship, etc.	8	15	0 to	8	17	6
Boiler plts.	8	7	6 to	9	5	0
Chequer plts.				10	7	6
Angles				8	7	6
Tees				9	7	6
Joists				8	15	0
Rounds and squares, 3 in. to 5½ in.				9	7	6
Rounds under 3 in. to ½ in. (Untested)	6	12	6 & up.			
Flats—8 in. wide and over				8	12	6
„ under 8 in. and over 5 in.				8	17	6
Rails, heavy	8	5	0 to	8	10	0
Fishplates				12	0	0
Hoops (Staffs)				9	10	0
Black sheets, 24g.				8	5	0
Galv. cor. shts.				10	0	0
Galv. flat shts.	10	10	0 to	11	0	0
Galv. fencing wire, 8g. plain				12	17	6
Billets, soft	4	17	6 to	5	7	6
Billets, hard	6	12	6 to	7	2	6
Sheet bars	4	12	6 to	5	2	6
Tin bars	4	12	6 to	4	15	0

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	10¾d.
Sheet to 10 w.g.	11¾d.
Wire	11¾d.
Rods	10¾d.
Tubes	16¾d.
Castings	12¾d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1½ to 1/7½
To 15 in. wide	1/1½ to 1/7½
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2½ to 1/8½
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3½
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	
to 10g.	1/4½ to 1/11½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	13.84
No. 2 foundry, Valley	14.50
No. 2 foundry, Birm.	11.00
Basic	15.39
Bessemer	16.89
Malleable	16.39
Grey forge	16.39
Ferro-mang. 80%, seaboard	68.00
O.-h. rails, h'y, at mill	43.00
Billets	26.00
Sheet bars	26.00
Wire rods	37.00
	Cents.
Iron bars, Phila.	2.11
Steel bars	1.60
Tank plates	1.60
Beams, etc.	1.60
Skelp, grooved steel	1.60
Steel hoops	1.55
Sheets, black, No. 24	2.20
Sheets, galv., No. 24	2.85
Wire nails	1.95
Plain wire	2.20
Barbed wire, galv.	2.60
Tinplates, 100-lb. box	$4.75

COKE (at ovens).

Welsh foundry	20/- to 22/6
„ furnace	16/- to 16/6
Durham and Northumberland—	
„ foundry	21/- to 25/-
„ furnace	12/- to 12/6
Midlands, foundry	—
„ furnace	—

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 per box		15/9 to 16/-
„	28×20	„	31/6 to 32/-
„	20×10	„	—
„	18¾×14	„	—
C.W.	20×14	„	—
„	28×20	„	—
„	20×10	„	—
„	18¾×14	„	—

SWEDISH CHARCOAL IRON & STEEL.

Pig-iron	£6 0 0 to £7 0 0
Bars-hammered, basis	£16 10 0 to £17 0 0
Bars and nail-rods, rolled, basis	£15 17 6 to £16 5 0
Blooms	£10 0 0 to £12 0 0
Keg steel	£32 0 0 to £33 0 0
Faggot steel	£18 0 0 to £23 0 0
Bars and rods dead soft, st'l	£10 0 0 to £12 0 0

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 18.16 to £1.]

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£	s.	d.		
Oct.	13 ..	32	2	6	dec.	6/3
,,	14 ..	31	10	0	,,	12/6
,,	17 ..	31	16	3	inc.	6/3
,,	18 ..	31	12	6	dec.	3/9
,,	19 ..	32	6	3	inc.	13/9

Electrolytic Copper.

		£	s.	d.		
Oct.	13 ..	36	5	0	dec.	5/-
,,	14 ..	36	0	0	,,	5/-
,,	17 ..	36	5	0	inc.	5/-
,,	18 ..	36	5	0	No change	
,,	19 ..	36	10	0	inc.	5/-

Standard Tin (cash).

		£	s.	d.		
Oct.	13 ..	151	7	6	dec.	2/6
,,	14 ..	149	15	0	,,	32/6
,,	17 ..	151	10	0	inc.	35/-
,,	18 ..	153	0	0	,,	30/-
,,	19 ..	153	2	6	,,	2/6

Tin (English ingots).

		£	s.	d.		
Oct.	13 ..	153	5	0	dec.	2/6
,,	14 ..	151	15	0	,,	30/-
,,	17 ..	153	5	0	inc.	30/-
,,	18 ..	154	15	0	,,	30/-
,,	19 ..	154	15	0	No change	

Spelter (ordinary).

		£	s.	d.		
Oct.	13 ..	14	15	0	dec.	2/6
,,	14 ..	14	7	6	,,	7/6
,,	17 ..	14	10	0	inc.	2/6
,,	18 ..	14	10	0	No change	
,,	19 ..	14	18	9	inc.	8/9

Spelter (Electro, 99.9 per cent.).

		£	s.	d.		
Oct.	13 ..	17	10	0	inc.	5/-
,,	14 ..	17	0	0	dec.	10/-
,,	17 ..	17	0	0	No change	
,,	18 ..	17	0	0	,,	,,
,,	19 ..	17	5	0	inc.	5/-

Zinc Sheets (English).

		£	s.	d.		
Oct.	13 ..	24	10	0	No change	
,,	14 ..	24	10	0	,,	,,
,,	17 ..	24	10	0	,,	,,
,,	18 ..	24	10	0	,,	,,
,,	19 ..	24	10	0	,,	,,

Lead (English).

		£	s.	d.		
Oct.	13 ..	13	15	0	No change	
,,	14 ..	13	10	0	dec.	5,-
,,	17 ..	13	10	0	No change	
,,	18 ..	13	5	0	dec.	5/-
,,	19 ..	13	15	0	inc.	10/-

Imports and Exports of Iron and Steel Castings in September and the nine months 1932, compared with September and the nine months 1931.

	September, 1931.	September, 1932.	Nine months, 1931.	Nine months, 1932.	September, 1931.	September, 1932.	Nine months, 1931.	Nine months, 1932.
Imports.	Tons.	Tons.	Tons.	Tons.	£	£	£	£
Pipes and Fittings, Cast	841	278	10,265	2,235	13,240	4,653	132,529	39,248
Castings, in the Rough, Iron	47	5	1,164	541	883	131	23,438	9,756
,, ,, ,, Steel	399	90	4,607	1,379	6,976	2,075	97,609	27,276
Hollow-ware, Cast, not Enamelled	8	22	64	44	419	1,169	4,435	2,856
,, ,, Enamelled	1	55	46	196	282	1,405	2,489	5,453
Exports.								
BUILDERS' CASTINGS—								
To Argentine Republic	71	19	686	281	3,959	1,055	32,413	10,445
,, Irish Free State	371	95	3,208	2,707	17,104	4,454	148,758	122,463
,, British South Africa	159	73	1,682	1,092	6,912	2,737	62,237	38,993
,, ,, India	82	75	1,036	629	2,730	3,170	37,586	22,243
,, New Zealand	7	37	285	261	433	2,004	17,980	13,789
Total (including other countries)	1,034	606	10,020	7,891	46,906	26,662	442,199	330,958
PIPES AND FITTINGS—CAST—								
To Argentine Republic	384	4	4,379	1,307	3,256	72	42,324	14,045
,, Irish Free State	1,045	284	11,014	5,028	13,813	3,852	124,724	69,834
,, British South Africa	384	185	6,084	2,967	4,345	2,794	71,172	37,487
,, ,, India	188	146	1,401	879	2,835	1,854	22,858	14,341
,, Straits Settlements and Malay States	88	285	2,229	1,872	1,383	2,424	24,151	19,401
Total (including other countries)	4,315	5,980	54,338	51,009	50,413	51,283	618,716	514,657
HOLLOW-WARE—								
Cast, not Enamelled, and Cast, Tinned	176	174	1,644	1,763	6,341	5,669	57,295	61,896
,, Enamelled	52	47	401	605	4,341	4,305	39,297	51,038
CASTINGS, in the rough—								
Iron	113	55	1,876	738	3,866	2,364	42,106	27,964
Steel	57	16	951	575	2,749	984	33,705	24,377

WILLIAM JACKS & COMPANY,
WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

CLARENCE CHAMBERS, 39, CORPORATION STREET, BIRMINGHAM.
13, RUMFORD STREET, LIVERPOOL.

PIG IRON

REGISTERED TRADE MARK

All grades FOUNDRY, HEMATITE, BASIC, SPECIALS, &c.

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM JACKS & COMPANY,
CENTRAL CHAMBERS, 93, HOPE ST., GLASGOW, C.2.
ZETLAND ROAD, MIDDLESBROUGH.

SMALL ADVERTISEMENTS.

Notice.

Small Advertisements in this section of the Journal are accepted at the prepaid rate of 6d. per line, first line in capitals counting two, average 6 words per line. Minimum charge for one insertion 3/-

(A remittance should accompany instructions.)

SITUATIONS VACANT AND WANTED.

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